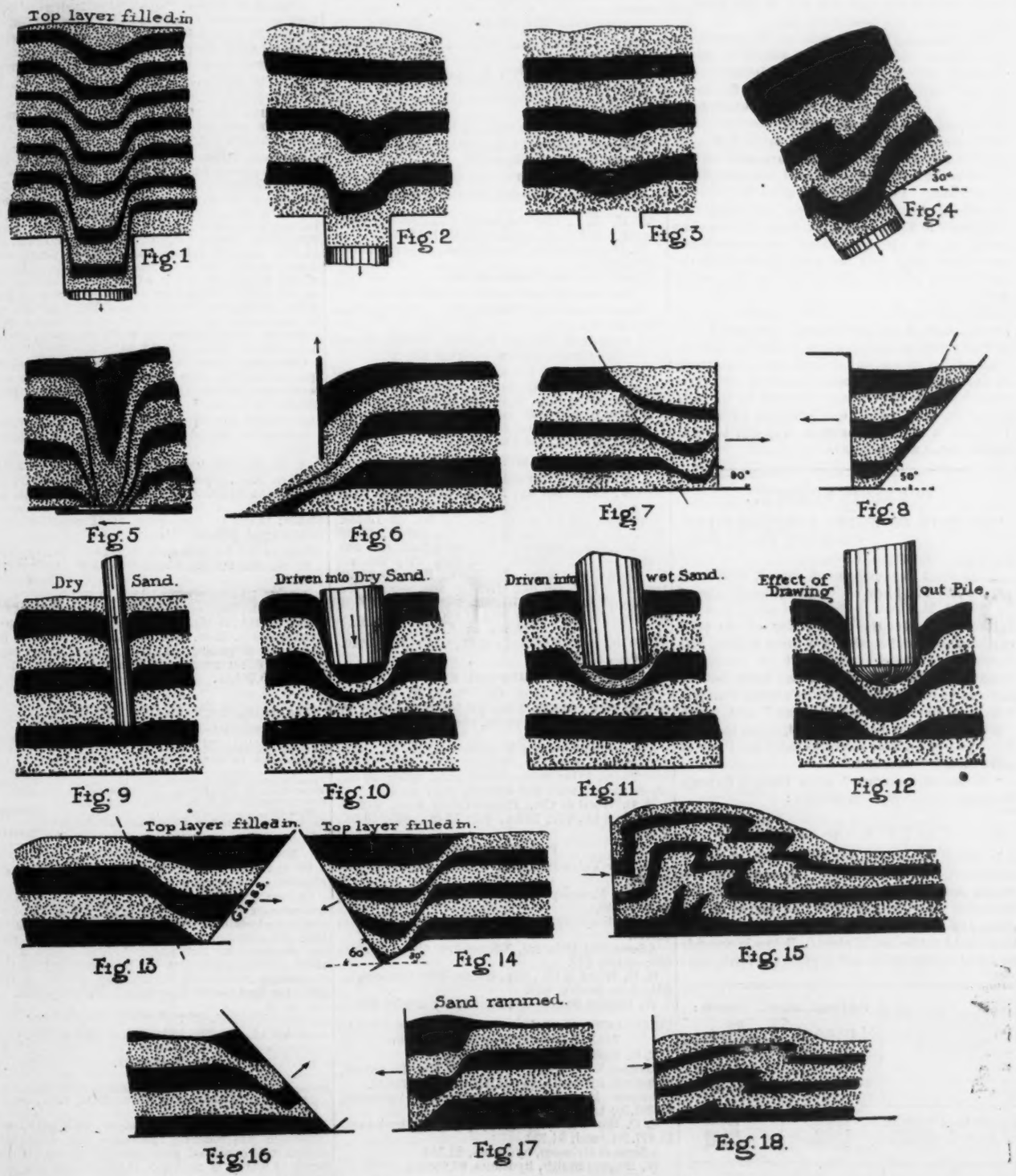
A STUDY OF THE MOVEMENT OF SAND.

In the January number of the "Journal of the Austrian Society of Engineers' and Architects," of Vienna, a paper is given by Ph. Forchheimer, on "The Pressure and Movement of Sand." The author makes but few deductions from his experiments, but we reproduce the more important of his illustrations and the methods he used, in the hope that they may be as instructive to our readers as they are novel and suggestive.

The materials used in these experiments were clean wire sand, fine shot, and very fine "iron-sand," such as was formerly used for blotting purposes. These materials were selected as representing a variety of angles of repose and differing in specific gravity. Only one of the above named materials was used at a time in making any single experiment. In the illustrations given, sand alone was used, arranged in layers of contrasting colors, so that the interior movement could be better observed and noted.

In Figs. 1, 2 and 3, the author's experiments were in the direction of illustrating the effect of a sinking foundation. The sand was dry, and, as plainly shown in Fig. 1, the mass over the sinking portion assumes the shape of that moving portion; in this case it is a vertical cylinder. Figs. 2 and 3, show that the distance through which each layer sinks decreases as they approach the surface, and as in Fig. 3, with only a slight settlement at the bottom, the top layer remains entirely unchanged. When wet sand was used, the sinking portion became a cone with apex uppermost, instead of a cylinder as in the experiment Fig. 1. Fig. 4 shows that the movement of the sand is vertical, even though the plane of the shifting foundation lie at an angle with the horizon. Fig. 5 is a case where dry sand is allowed to run out of a bottom opening for a



A STUDY OF THE MOVEMENT OF SAND.

few moments. Fig. 6 shows the deformation of the layers when a side opening is made at the bottom. Figs. 7 and 8 represent the effect of moving a wall horizontally outward, whether the wall has a vertical or inclined surface.

Figs. 9 and 10 show the disturbing effect upon the sand layers of piles driven into dry sand, Fig. 11 the same in wet sand, and Fig. 12 the result of drawing out a pile from dry sand.

The remaining figures relate to the movement of confining walls in different directions and to different degrees. Fig. 13 is an inclined wall moved horizontally, and away from the sand. Fig. 14 is an inclined wall shifting outward and downward at angle of 30° with the horizon. Fig. 16 is a wall moved outward and upward at angle of 40°. Fig. 17 is the sand in movement as Fig. 7, but in the first figure the sand was compacted by ramming. Figs. 15 and 18 show the effect of pressing a vertical wall against dry sand, the movement in Fig. 15 being six times greater than in Fig. 18. It will be noticed that in neither of the latter cases does the plane upon which the sand moves pass through the foot of the vertical wall.

To fix the sand layers in any required position in the course of his experiments, the author used melted paraffine, and was thus enabled to saw the consolidated mass in any desired plane, and study at his leisure the direction taken by any single layer. In the experiment recorded as in "wet sand," the same result was obtained by making the trial while the paraffine was still hot and liquid; water was not used.

CORRESPONDENCE.

THE FLOW OF WATER THROUGH PIPES.

CINCINNATI, Feb. 20, 1883.

EDITOR ENGINEERING NEWS:

DEAR SIR: In your issue of Jan. 13, 1883, is an article on "The Flow of Water Through Pipes," by Wm. J. McAlpine, in which he states that the formula he used in the construction of the table of discharges, contained in the same article, was Darcy's for oxidated pipes, which he considered suited to the case in hand. He also states that the formula he used was not "Darcy's usual formula, which is for clean smooth pipes," and which "gives a little less discharge for pipes less than 18" diameter—and a little more discharge for those of more than 18" diameter."

"Adams on Sewerage" gives Darcy's formula for clean smooth pipes as follows:

$$\text{Velocity per second} = \sqrt{\frac{d^3 H}{.00371\ (d+1)\ L}}$$

In which dimensions are all in feet, except d (diameter), which is in inches. Inasmuch as the results obtained from this formula contradict the statement above, in regard to the excess of discharge by the two formulæ, it seems an explanation would not be out of place. Below is appended a few results which will explain the foregoing:

Fall 1 in 100.	For Rough Interior. Formula: Vel. per sec. $= \sqrt{\frac{RS}{.0000057\ (H\ .23\ R.)}}$ Wm. J. McAlpine's Article.	
	Velocity.	Discharge.
Size 4 ft. (area 12.5664).	11.943	150.08
" 8 " (" 50.2656).	17.739	891.68
" 12 " (" 113.0976).	22.1096	2,500.54

Fall 1 in 100.	For Smooth Interior. Formula: Vel. per sec. $= \sqrt{\frac{d^3 H}{.00371\ (d+1)\ L}}$ From Adams' "Sewerage."	
	Velocity.	Discharge.
Size 4 ft. (area 12.5664).	11.258	141.47
" 8 " (" 50.2656).	16.00	804.25
" 12 " (" 113.0976).	19.633	2,220.45

It will be seen that the results for rough interior exceed those for smooth interior! If either formula is not correctly stated, it should be known.

Respectfully, PAX.

GLOUCESTER CITY (N. J.) WATER-WORKS.

On Feb. 15 the following bids for furnishing the material and doing the work were opened by the Council:

SUBSIDING RESERVOIR AND PUMP WELL.

John Eschbach, Philadelphia, as per specification, $5,600.

Aaron Ward, Camden, N. J., condition that no artificial foundation is required, $6,791.

Edward Schules, Gloucester City, as per specifications, $9,890.

ENGINE HOUSE AND STACK.

Thomas Leeming, Philadelphia, as per specifications and drawings, $5,556.97.

WATER TOWER.

John Baizley, Philadelphia, as per specifications, $5.87.

J. H. & T. Cunningham, Charleston, Mass., cornices and crest railway omitted, $5,900.

W. Bugbee Smith, Philadelphia, as per specifications, $6,223.

Gloucester Iron Works, $6,000.

FOUNDATION AND BASE OF WATER TOWER.

Thomas Leeming, Philadelphia, as per specifications, $2,275.

ONE COMPOUND CORLISS PUMPING ENGINE OR TWO CONDENSING CORLISS PUMPING ENGINES.

Robert Wetherill & Co., Chester, Pa., compound condensing pumping engine, boilers and foundation complete; duty, 90,000,000 ft. lbs., $14,550.

Robert Wetherill & Co., two condensing pumping engines, boilers and foundation complete; duty, 65,000,000 ft. lbs., $14,550.

IRON PIPES AND SPECIAL CASTINGS.

A. H. McNeal, Burlington, N. J., pipe at $37.50 per ton, 1.674c. per lb.; 100 ft. 20-in. pipe, 158⅛ lbs. per ft., 15,833 lbs. at 1.674c., $265.04; 2,875 ft. 16-in. pipe, 122 lbs. per ft., 350,750 lbs. at 1.674c., $5,871.55; 460 ft. 12-in. pipe, 70 lbs. per ft., 32,200 lbs. at 1.674c., $539.03. Pipe at $38.25 per ton, 1.708c. per lb.; 10,500 ft. 8-in. pipe, 43⅛ lbs. per ft., 455,000 at 1.708c., $7,771.40. Pipe at $38.75 per ton, 1.708c. per lb.; 11,700 ft. 6-in. pipe, 30 lbs. per ft., 351,000 lbs. at 1.719c., $6,033.69. Pipe at $39 per ton, 1.741c. per lb.; 11,600 ft. 4-in. pipe, 18½ lbs. per ft., 212,666 at 1.741c., $3,702.51; 52,500 lbs. special castings at 3½c. per lb., $1,640.62; total, $25,823.84.

STOP VALVES AND FIRE HYDRANTS.

Ludlow Valve Mfg. Co., Troy, N. Y., 4-in., $11.25; 6-in., $18.45; 8-in., $26.90; 12-in., $50; 16-in., $88; 20-in., $146; 20-in., check hub, $175; 20-in., check flange, $182.

Jonson Foundry and Machine Co., N. Y., 4-in., $11.50; 6-in., $19; 8-in., $27.50; 12-in., $42; 16-in., $89; 20-in., $115; 20-in., check hub, $350; 20-in., check flange boxes and corners, 3½c. per lb.

R. D. Wood & Co., Philadelphia, 4-in., $12; 6-in., $19; 8-in., $27; 12-in., $55; 16-in., $95; 20-in., $125.

FIRE HYDRANTS.

Ludlow Valve Mfg. Co., double, $31.40; single, $29.60.

Jonson Foundry and Machine Co., double, $40; single, $40.

E. G. Smyser, York, Pa., two studs, double, $33.75.

Adams and Griscom, Gloucester City, double, $29; single, $27.

R. D. Wood & Co., 3-in. single, $32; 4-in. single, $34; 4-in. double, $35.

W. Bugbee Smith, double, $41.50; single, $37.

CALCULATED ON MEAN OF ABOVE PRICES.—TOTAL VALVES AND HYDRANTS SPECIFIED.

E. G. Smyser, hydrants, $1,856.25.

Ludlow Valve Mfg. Co., Bid No. 1, valves, $1,946.95; hydrants, $1,677.50; total, $3,624.45.

Jonson Foundry, valves, $1,851; hydrants, $2,392.50; total, $4,243.50.

R. D. Wood & Co., valves, $1,821.50; hydrants, $2,777.50; total, $4,599.

Adams & Griscom, hydrants, $1,540.

W. Bugbee Smith, hydrants, $2,158.75.

LAYING AND CONNECTING IRON PIPES AND SPECIAL CASTINGS.

James J. Cogan, Bergen Point, N. J., 100 ft. 20-in. pipe at 50 cents per foot, $50; 2,875 ft. 16-in. pipe at 46 cents, $1,322.50; 460 ft. 12-in. pipe at 35 cents, $161.00; 10,500 ft. 8-in. pipe at 30 cents, $3,150; 11,700 ft. 6-in. pipe at 25 cents, $2,925; 11,600 ft. 4-in. pipe at 20 cents, $2,320; setting 55 hydrants at $4.50, $247.50. Total, $10,176.

Charles J. Everson and F. P. S. Crane, Middletown, N. Y., 11,600 ft. 4-in. pipe at 31 cents, $3,296; 11,700 ft. 6-in. pipe at 33¾ cents, $3,890.25; 10,500 ft. 8-in. pipe at 39 cents, $4,095; 460 ft. 12-in. pipe at 47 cents, $216.20; 2,875 ft. 16-in. pipe at 54¼ cents, $1,559.69; 100 ft. 20-in. pipe at 52 cents, $52.00; setting 55 hydrants at $4, $220. Total, $13,629.14.

Adams & Griscom, 100 ft. 20-in. pipe at $1, $100; 2,875 ft. 16-in. pipe at 60 cents, $1,725; 460 ft. 12-in. pipe at 45 cents, $207; 10,500 ft. 8-in. pipe at 28 cents, $2,940; 11,700 ft. 6-in. pipe at 21 cents, $2,457; 11,600 ft. 4-in. pipe at 19 cents, $2,204; setting 55 hydrants at $3, $165. Total, $9,798.

Thomas H. Regan, Philadelphia, laying and connecting couplets as per specifications, $7,381.20; setting 55 hydrants at $2, $110; setting 84 stop valves at $1.50, $126. Total, $7,617.20.

BIRKINBINE'S PATENT FIRE PROTECTION APPARATUS.

H. P. M. Birkinbine, Philadelphia, complete as per specifications, $2,500.

FURNISHING ALL PIPES, SPECIAL CASTINGS, STOP VALVES AND FIRE HYDRANTS AND LAYING AND CONNECTING THE SAME.

James J. Newman & Co., Providence, R. I., 100 ft. 20-in. pipe at $3.15, $315; 2,875 ft. 16-in. pipe at $2.45, $7,043.75; 460 ft. 12-in. pipe at $1.56, $717.60; 10,500 ft. 8-in. pipe at 96 cents, $10,080; 11,700 ft. 6-in. pipe at 72 cents, $8,424; 11,600 ft. 4-in. pipe at 51 cents, $5,916. Total for all pipes, $32,496.35. Furnishing 52,500 lbs. special castings at 3½ cents, $1,837.50. 55 Mathews single hydrants at $36, $1,980; 55 Mathews double hydrants at $38, $2,090, $2,035. Thirty-nine 4-in. stop valves at $15, $585; twenty-four 6-in. stop valves at $24, $576; sixteen 8-in. stop valves at $30, $480; one 12-in. stop valve, $27; three 16-in. stop valves at $93, $279; one 20-in. stop valve, $125; one 20-in. check valve, $190. Total, $38,665.85.

Gloucester Iron Works, furnishing all pipes, special castings, stop valves and fire hydrants and laying and connecting the same complete $35,224.50.

FURNISHING THE PIPE LAID COMPLETE, VALVES AND HYDRANTS TO BE FURNISHED BY GLOUCESTER CITY.

A. H. McNeal, 100 ft. 20-in. pipe at $3.64, $364; 2,875 ft. 16-in. pipe, at $2.60, $7,733.75; 460 ft. 12-in. pipe, at $1.54, $708.40; 10,500 ft. 8-in. pipe, at $1, $10,500; 11,700 ft. 6-in. pipe, at 74 cents, $8,658; 11,600 ft. 4-in. pipe, at 51 cents, $5,916. Grand total, $33,880.15.

FURNISHING THE PIPE LAID COMPLETE, VALVES AND HYDRANTS TO BE FURNISHED BY GLOUCESTER CITY.

John E. Eschbach, furnishing 11,600 ft. 4-in. pipe at 58 cents, $6,728; 11,700 ft. 6-in. pipe at 78¾ cents, $9,213.75; 10,500 8-in. pipe at $1.02¼, $10,736.25; 460 ft. 12-in. pipe at $1.50, $690; 2,875 ft. 16-in. pipe at $2.35¾, $6,777.81; 100 ft. 20-in. pipe at $279, $279; setting 55 hydrants at $2, $110. Total, $35,534.81.

AWARDS.

The contracts were awarded as follows:

Subsiding reservoir to J.E.Eschbach, Philadelphia, at	$5,600.00
Pipe system, complete, to same at	35,534 81
Engine-house to Thomas Leeming, Philadelphia, at	5,565 97
Foundation of water-tower to same at	2,275.00
Water-tower to John Baizley, Philadelphia, at	5,870.00
Fire protection to H. P. M. Birkinbine, Philadelphia, at	2,500.00
Engineering to H. P. M. Birkinbine, Philadelphia, at	2,500.00
Total	$73,395.78

From the New York *Times* of last Sunday we clip the following item:

GLOUCESTER CITY, N. J., Feb. 24.—An injunction has been served on the City Council of this city to restrain the building of water-works upon the ground that the contract for a portion of the work was not awarded to the lowest bidder. This is the third time an injunction has been granted by the Chancellor restraining the building of water-works here, the first two having been made perpetual.

CANAL NAVIGATION IN BELGIUM.*

BY A. GOBERT.

[From selected papers of the Institution of Civil Engineers, translated and abstracted by Alfred Bache, B. A., Assoc. Inst. C. E.]

The first portion of this paper deals with the improvements recently proposed for what the author calls canals of *mean* section, in which the depth of water is not less than two meters nor more than three (say from 6½ to 10 ft.) The second portion treats of *maritime* canals, defined as having not less than five meters (say 16½ feet) depth of water; and investigates the various plans lately brought forward in Belgium for canals of this class. The expression "average annual traffic" is taken to denote the tonnage arrived at

* This paper (appearing in the "Revue Universelle des Mines," 1881, vol. ix., pp. 356-400, 469-490; and vol. x., pp. 95-134), formed part of a competitive essay, which was written in 1880, on the Development of Belgian Commerce, and which was adjudicated a work of more than ordinary merit, eliciting the comment that, in dealing with the question of canal navigation, the accuracy of the calculations employed and the fairness of the views advanced were evidence of a thoroughly sound acquaintance with the subject.

as the quotient when the total ton-miles resulting from a year's traffic in both directions are divided by the length of the canal. "Freight" includes all expenses pertaining to towing boats, boatmen, and return of empties. Interest on capital, maintenance of works, and working of locks, together make up the "tolls."

I.—CANALS OF MEAN SECTION.

In reports on the improvement of canals of this class in France, drawn up in 1872–74 by M. Krantz, and in 1878 by the minister of public works, M. de Freycinet, the conclusion arrived at by both authorities was that in any country it was highly important, alike for agriculture and for other industries, that there should be a net-work of canals, running somewhat parallel to that of the railways, wheresoever there was altogether traffic enough to pay the interest on both the canal and the railway capital; to which the author adds that, in order to insure co-operation instead of competition, both modes of carriage ought to be under one and the same management, which he considers ought to be controlled by the government. The chief aim of improvements should be to bring about uniformity of section, which is sadly wanting in the present canals in France and elsewhere, as pointed out both by M. Krantz and by M. Théophile Finet, a Belgian engineer. French canals are classed as "main" and "secondary," the former being under government administration, while the latter are leased with or without subsidy. The main canals are required to have 2 meters = 6½ ft. depth of water, with locks 5.2 meters = 17 ft. wide and 38.5 meters = 126 ft. long. The administration of the main canals by the government is understood to imply their maintenance by the State, and the working of the locks, subject to the tolls; the option of the tractive power to be employed is also reserved to the government, which, however, undertakes no responsibilies of any kind in regard to the actual conveyance of the traffic. For the working of the canals it is considered essential in France that the bargees with their families should continue, as hitherto, to live in their boats.

In Belgium views have latterly been advanced which are altogether contrary to those current in France. In his book of 1878, M. Finet recommended single-width canals worked on a similar plan to railways, doing away with the bargees, and making up a train of barges with a tug in front and a steering barge in rear, all the intermediate barges having flat vertical ends, slightly rounded below water-line, instead of anything like prow and stern. Since the power required to tow a boat is independent of its length, the expense of towing would thereby be reduced to a minimum. The whole train might carry 1,000 tons, in five to ten barges containing 200 to 100 tons each; its total length would be about 140 meters or 460 ft., and it would only want two men on the tug and either one or two men on the rear barge. The locks would have to be 150 meters or 490 ft. long, in order to avoid breaking up a train.

Cost of Carriage by Canal and by Rail.—In advocating his own ideas, M. Finet charged railways and bargee canals with not being able to carry goods cheaply enough. The author proceeds therefore to examine the net cost of carrying heavy goods by the best ordinary canals on the bargee system, and by railway, and to show that M. Finet's single-width and long-lock scheme with train of barges would not carry more cheaply than could be done by the present system when improved as it ought to be. In his report of 1874, M. Krantz assumed that canal traffic, like that of railways, ought to pay, including interest and redemption, 5.65 per cent. on the capital sunk, which averages for canals 180,000 francs per kilometer (£11,500 per mile); it must also pay maintenance of works, and working of locks, which together are taken to average yearly 1,450 francs per kilometer (£93 per mile); and further it must pay "freight" (as already defined), which he assumes as an invariable charge of 1.5 centime per tonne-kilom. = 0.234 penny per ton per mile. On these assumptions it is readily shown in a tabular form how largely the net cost of canal carriage is affected by the total amount of the traffic; thus, with an average annual traffic of only 50,000 tonnes-kilom. (say 30,000 ton-miles) the net cost would rise to as much as 24.74 centimes per tonne-kilom. = 3.853 pence per ton per mile, which is as high as carting by road would be; while twenty times as much traffic, or 1,000,000 tonnes-kilom. (say 600,000 ton-miles), would bring the net cost down to only one-ninth, or 2.66 centimes per ton kilom. = 0.414 penny per ton per mile. To the freight charge of 1.5 centime per tonne-kilom. = 0.234 penny per ton per mile, derived by M. Krantz from the canals in the north of France, exception is taken by the author, who examines separately the several items that go to make up the freight—towing, boats, boatmen and return of empties.

Steam Towing.—On the Willebroeck Canal, which runs north from Brussels past Willebroeck and enters the river Rupel opposite Boom, all boats except steamers are towed by a steam-tug working on a chain. The length of the canal is 28 kilom. = 17¼ miles, divided into five levels; the locks are large enough to take in six or seven boats at a time, along with their tug. The towing is done by a company, from whose scale of charges and a year's balance-sheet the author deduces 5 millimes* per tonne-kilom. = 0.078 penny per ton per mile, as the actual price paid for towing, the total annual traffic amounting to 25,200,000 tonnes-kilom. (say 15,400,000 ton-miles). But if the actual dividends were reduced to the rate of 4 per cent., which prevails for Belgian government securities, and if certain economies were effected which he believes to be practicable, the author considers the charge for towing might be brought down to 3 millimes per tonne-kilom. = 0.047 penny per ton per mile, including empties free.

Horse Towing.—On two Belgian canals, the Louvain and the Charleroi, horses are employed for towing. The Louvain canal is semi-maritime, with 3½ meters = 11½ ft. depth of water, and runs northwest from Louvain to the river Senne, which flows into the Rupel about 1 kilom. or ⅝ mile further northwest. Its length is 30 kilom. = 18¾ miles, divided into five levels; the total tonnage of the boats and ships passing through it in 1878 is estimated by the author at 273,000 tons, and the charge for towing averages 6 millimes per tonne-kilom. = 0.093 penny per ton per mile. The Charleroi canal, winding northward from Charleroi to Brussels by a circuitous route of 75 kilom. = 47 miles, is of small section, and its boats all alike carry only 70 tons; hence the charge for towing is higher, amounting to 8 millimes per tonne-kilom. = 0.125 penny per ton per mile. Including return of empties, the author estimates that horse towing might be done on government canals for 5 millimes per tonne-kilom. = 0.078 penny per ton per mile; while Dr. Meitzen, a German authority, has arrived at an estimate of from 4.2 to 5.1 millimes = 0.065 to 0.079 penny.

Boats, Boatmen and Empties.—The 110-ton boats in general use by the carriers on the Willebroeck Canal make weekly the double journey from Brussels to Antwerp and back; the distance by the canal, the Rupel and the Scheldt, is 45 × 2 = 90 kilom. = 56 miles there and back. The boatman gets 70 francs = 56s. per week for himself and his boat. With a full load each way, this would give 7 millimes per tonne-kilom. = 0.109 penny per ton per mile. When the Charleroi Canal is enlarged, the author anticipates a large traffic right through from Charleroi to Antwerp, a distance of 120 kilom. = 75 miles; a single journey per week would then bring the cost down to 5.2 millimes = 0.081 penny. German estimates by Dr. Meitzen range from 4.8 to 6.4 millimes = 0.075 to 0.100 penny. Whence the author takes 5 millimes per tonne-kilom. = 0.078 penny per ton per mile as the cost of boats and boatmen, with a full load both ways, traveling 17 kilom. or 11 miles per day, including all stoppages. One empty return in two double journeys is as much as occurs in Belgium; this is equivalent to making every journey with three-quarters of a full load, whereby the above figures would be increased one-third, giving 6.6 millimes per tonne-kilom. = 0.103 penny per ton per mile.

Net Cost of Canal Carriage.—Applying the foregoing estimates to an assumed average annual traffic of 1,000,000 tonnes-kilom. (say 600,000 ton-miles), the author arrives at 18.2 and 20.2 millimes per tonne-kilom. = 0.284 and 0.315 penny per ton per mile as the net cost of canal carriage, with steam and horse towing respectively. These amounts are made up as follows:

		Per tonne-kilométrique. Millimes.	Per ton per mile. Penny.
Tolls	Interest and redemption, at 5 per cent.	7.2	0.112
	Maintenance and locking	1.4	0.022
Freight	Steam towing	3.0	0.047
	Boats, boatmen and empties.	6.6	0.103
	Totals with steam towing	18.2	0.284
Horse towing, excess over steam.		2.0	0.031
	Totals with horse towing	20.2	0.315

Net Cost of Carriage by Rail.—From French statistics of 1867 M. Krantz arrived at 38 millimes per tonne-kilom. = 0·592 penny per ton per mile as the actual minimum charge for the carriage of heavy goods by rails, which he considered might be subdivided nearly as follows:—

	Per tonne-kilom. Millimes.	Per ton per mile. Penny.
Locomotive power	9	0·140
Rolling stock	5	0.078
Wages and maintenance	5	0.078
Interest and general charges	19	0.296
Totals	38	0.592

Subsequently he gave 35 millimes = 0·545 penny as the minimum charge practicable. At this rate he argued that a canal could not compete with a railway, unless it could secure a traffic averaging yearly at least 600,000 tonnes per kilom. (say 370,000 tons per mile). But in the absence of railway communication, a canal would pay with only one-quarter to one-sixth of that amount of traffic.

In Belgium, where interest on capital is about all the profit the State railways are expected to earn, the net cost of carriage comes nearer to the charge made for it. The lowest charge is stated by M. Sainctelette, the Minister of Public Works, to have occurred in 1878, and to have amounted to 31 millimes per tonne-kilom. = 0.483 penny per ton per mile. The coal traffic from the province of Hainault to Paris was charged in the same year 35.8 millimes per tonne-kilom. = 0.558 penny per ton per mile by the Northern Railway of France; notwithstanding this competition, the canal navigation of 283 kilom. = 177 miles from Belgium toward Paris had a coal ton-mileage amounting to nearly half as much as that by rail. M. Sainctelette concludes that, in spite of new or improved canals, the railways will continue to carry large quantities of coal and to earn an important revenue for the State; while at the same time, however low be the charge for carriage by rail, the freight by water can be made lower still. That 31 millimes = 0.483 penny is about the lowest charge practicable for goods traffic on the Belgian railways is confirmed, in the author's opinion, by the fact that their passenger fares have lately had to be raised 5 per cent. in order to yield the required revenue. The canal charges, already arrived at, of 18.2 or 20.2 millimes = 0.284 or 0.315 penny, are therefore seen to be fully one-third less than the minimum charge for carriage by rail.

M. Finet's scheme of Single-width Canals.—The tempting prospect of towing a train of ten 100-ton barges with scarcely any more power than would be required to tow only one of them, and the alluring advantages of speedily loading each separate barge, and of detaching and attaching barges at intermediate wharves along the canal's course, are considered by the author to disappear when looked into practically. A single-width canal would lose the great advantage which the ordinary double-width canals now possess over railways, of allowing boats to stop at any spot whatsoever, for loading or discharging cargo. A regular time-table would have to be strictly enforced; all boats would have to be made up into trains, involving loss of time at starting; there would be delays at the turn-outs, where the canal was widened for allowing the return trains to pass; and steamers could no longer go where and when they pleased. Bridges and locks, being already of single width, could be built no cheaper; while the proposed long locks of 150 meters = 490 feet length, to take a train of barges, would cost vastly more than the present French locks of 38.5 meters = 126 feet length. Even with very few locks, a single-width canal would not come more than one-ninth cheaper than the ordinary canals of double width; at the outside therefore it would not take off more than 1 millime per tonne-kilom. = 0·016 penny per ton per mile from the tolls. Under the head of towing, the only possible saving would be in consumption of coal in the steam tugs, which on the Willebroeck canal costs about ½ millime per tonne-kilom. = 0.008 penny per ton per mile; if half this were saved on a single width canal, ¼ millime = 0.004 penny would be all the economy thereby effected. As for dispensing with bargees on all except the tug and the rear barge of a train, the author considers it would be practically impossible to work a train of rudderless barges round the bends of a canal, and a most tedious and difficult job to handle the barges separately at the wharves and docks where the train has to be made up or dispersed; moreover the cargoes would not get properly watched, with so few men to look after them. The total saving possible on a single-width canal, of 1¼ millime per tonne-kilom. = 0.020 penny per ton per mile, would be swallowed up, the author believes, by the extra management expenses consequent upon having to organize the canal service on a similar plan to that of railways. He points out also that interest on original capital has been omitted from M. Finet's estimated cost of canal carriage, which is charged only with the interest on capital expended in improving the existing canals, thereby vitiating the comparison with carriage by rail; while the unexplained assertion that 1 millime would cover the "freight" on a single-width canal is met by the author's foregoing analysis, which shows 9.6 millimes per tonne-kilom. = 0.150 penny per ton per mile, to be about the actual minimum. In preference to any such scheme as that of single-width canals, the author recommends the plan of navigation already carried out upon the Willebroeck canal, where boats and boatmen are hired yearly by carrier firms, and goods are conveyed as safely and punctually (except in frosts) as by rail. This plan he expects will undergo a vast extension as soon as ever there is a good system of canals reaching from Antwerp to Charleroi, Mons and Paris, and from Antwerp to Ruhrort on the Rhine.

Canal Carriage Compared with Sea.—While long sea voyages, in which thousands of tons are carried thousands of miles, offer too great a contrast to canal navigation, the latter may very fairly be compared with short sea passages and coasting trips, in which a few hundred tons are carried only a few hundred miles. From London to Antwerp, a distance of about 350 kilometers, or, say,

* That is the one-thousandth part of a franc.

220 miles, the freight by steamer is 21.5 millimes per tonne-kilom = 0.335 penny per ton per mile, which agrees very closely with the author's estimate of 18.2 to 20.2 millimes = 0.284 to 0.315 penny for canal carriage. The canal charge covers maintenance of waterway and interest, etc., on construction; the sea charge, while free from both of these, includes other costs not incident upon canals.

II.—MARITIME CANALS.

Terneuzen Canal.—Referring to the powerful advocacy of MM. Colson, De Maere-Limnander and De Grandvoir in favor of constructing ship canals in the provinces of Brabant, Flanders and Liége, the author points out that their arguments are altogether of a general character, and are not backed up with detailed estimates of profit and loss, such as ought to be made out beforehand in connection with each of the several projects. He recommends watching the results that will ensue from the deepening just commenced of the existing Terneuzen ship canal, constructed in 1°24-7, which runs northward 34 kilom. = 21 miles, from Ghent to Terneuzen, in the estuary of the Scheldt. The upper level of this canal, extending 20.854 kilom., say 13 miles, north from Ghent to Sas-de-Gant (Ghent Lock), has only 4.4 meters, or 14½ ft., depth of water, so that no vessel of more than 4 meters, or 13 ft., draught can get up to Ghent; while in the lower or northern level of 13.187 kilom., say 8 miles, length the depth increases from 4.32 meters, or 14½ ft., at Sas-de-Gant to 5.66 meters, or 18½ ft., at the sea-lock at Terneuzen, where vessels of 5.3 meters, or 17¼ ft., draught can accordingly enter at the lowest tides. The bottom is now to be deepened throughout the canal's entire length from Terneuzen to Ghent to a uniform depth of 4.02 meters = 13.2 ft. below Dutch datum A. P.,* so as to give 6.5 meters = 21.3 ft. depth of water in the upper level, and 6.05 meters = 19.8 ft. in the lower. The two locks, at Ghent and at Sas-de-Gant, are to be made 0.25 meter = 10 in. deeper still than the new bottom, with a view to the canal being further deepened to that extent whensoever the time may come for a new sea-lock to be constructed at Terneuzen.

Competing Ports.—Six general considerations are advanced by the author in respect to the question of constructing maritime canals. In the first place, the advantage of competing ports is illustrated by the virtual monopoly at present held by Antwerp, where all traffic (except rails and ores) that does not come in river boats has to be carted at a cost per ton of 1½ francs = 14¼ pence and upward. The consequence is that certain large works in the Liége district avoid Antwerp by making Terneuzen their port instead.

Avoidance of Transhipment.—Secondly, the minimum charge of 1½ francs = 14¼ pence per ton for transhipment at Antwerp would carry the goods by rail a distance of 48 kilom. = 30 miles, taking the railway rate previously arrived at of 31 millimes per tonne-kilom. = 0.483 penny per ton per mile. The saving of transhipment will benefit any canal in the inverse ratio of its length.

Propinquity of Existing Canals.—Thirdly, it will not pay to make a ship canal through a district already served by an ordinary canal, unless there be traffic enough to insure a profit after debiting the ship canal with the loss it will entail upon the existing canal, which is certain to be thrown idle.

Traveling Night and Day.—Fourthly, the present custom in Belgium is for canal boats to travel by day only; but they might safely do so by night also, provided it were arranged that the up and down traffic should go on alternate nights. In that way, for instance, the present six days' journey from Charleroi to Brussels would be completed in only four days, the boats traveling two alternate nights and stopping the other two. More men would then be wanted for the ordinary canal-boats, as well as for the locks; but ships have, of course, an ample crew already.

Sea-borne Commerce.—Fifthly, ship canals attract to sea-borne commerce capital which would not otherwise be so embarked. The importance of capital in this connection is illustrated by the success which has attended the Amsterdam ship canal, and which Flushing, despite her quays and cranes, so signally lacks. Had Brussels, out of her redundancy of capital, dowered Antwerp with adequate means of warehousing cotton and corn, the author believes a highly lucrative trade in both these commodities might already have been secured to Belgium; and he looks forward to the advantages which will accrue from rendering Brussels a large sea-port through the projected ship canal of 30 kilom. = 19 miles to the Scheldt.

Net Cost of Carriage by Ship Canal.—Sixthly, taking a 1,000-ton steamer to burn coals to the value of 225 francs = £9 per day when doing her 360 kilom. = 225 miles in 24 hours at sea, this is equivalent to 62.5 centimes per kilom. = 9.58 pence per mile. On the Erie canal, with locks 8 kilom. = 5 miles apart, the goods steamers do 64 kilom. = 40 miles per 24 hours. Assuming only 60 kilom. = 37½ miles per 24 hours on ship canals in Belgium, and the same consumption for this lower speed as for the higher speed at sea, the coal burnt on the ship canal will cost 37.5 francs = £1 10s. per day. Interest, redemption, insurance and wages may be taken to make up a fixed charge of 400 francs = £16 per day. Hence the freight is altogether 437.5 francs = £17 10s. per day, or 7.3 millimes per tonne-kilom. = 0.114 penny per ton per mile; and adding one-third as before to allow for empties, the actual freight becomes 9.7 millimes per tonne-kilom. = 0.151 penny per ton per mile, or very closely the same as the freight previously arrived at for the ordinary canal boats. According to their size, the proposed ship canals in Belgium would cost for construction and maintenance, some of them about twice and others about three times as much as the ordinary canals; their depths of water would be 5 meters or 16½ ft. and 6¾ meters or 22 ft. respectively, and they would be large enough for steamers up to 1,000 tons and 3,000 tons respectively. The tolls previously ascertained of 8.6 millimes per tonne-kilom. = 0.134 penny per ton per mile on the ordinary canals, with an average annual traffic of 1,000,000 tonnes-kilom. (say 600,000 ton-miles), would therefore become 17.2 millimes = 0.268 penny, and 25.8 millimes = 0.402 penny for the same amount of traffic on the smaller and larger maritime canals respectively. The net cost of carriage on the two sizes of ship canals would accordingly stand as follows, in millimes per tonne-kilom. and pence per mile:

Depth of water in canal	5.00 meters = 16.4 ft.	
Tolls	17.2 millimes = 0.268	penny
Freight	9.7 " = 0.151	"
Totals.....	26.9 " = 0.419	"
Depth of water in canal.....	6.75 meters = 22.1 ft.	
Tolls.....	25.8 millimes = 0.402	penny
Freight.....	9.7 " = 0.151	"
Totals	35.5 " = 0.553	"

As examples of the advantages resulting from ships being able to make their way up to inland ports at a distance from the sea, the author refers to the large amount of traffic passing up the Seine in sea-going vessels to Rouen, a distance of 124 kilom. = 77 miles inland from Havre. On the Terneuzen canal the tonnage going up to Ghent in ships was trebled from 1870 to 1878; while in the same period that going up the Scheldt to Antwerp was only doubled. The Amsterdam ship canal, of 28 kilom. = 17½ miles length and 7 meters = 23 ft. depth of water, has already, since its opening at the end of 1876, caused a rapid increase in the commercial importance of Amsterdam. From official statistics compiled for the Belgian Parliament* in 1878 by the late Baron Jacques Behr, the seven Belgian ports rank in the following order of commercial importance: Antwerp, Ostend, Ghent, Louvain, Brussels, Bruges, Nieuport. Antwerp alone takes 85 per cent. of the entire sea tonnage of Belgium, leaving only 15 per cent. for the six secondary ports together. In the British Isles the proportions are 40 per cent. for London and Liverpool jointly, and 60 per cent. for the one hundred and twenty-two secondary ports. In France also the same proportions obtain: Marseilles and Havre together absorb 40 per cent., leaving 60 per cent. for the seventy-three secondary ports. The inference is that, if Belgium had secondary ports easily accessible for large ships these secondary ports would enjoy a share of traffic corresponding with that of similar ports in other countries. The traffic at Antwerp by ships, railways, and river and canal-boats, is analyzed by the author; and the physical geography of the Belgian sea-coast and of the Scheldt estuary is described, which clearly points out the Scheldt as the great highway to the sea for Belgium.

Proposed Maritime Canals.—The author examines in detail the commercial and engineering aspects of the several ship canals proposed within the last eight years for the provinces of Flanders, Brabant and Liége. The Flanders project†—for the construction of a harbor and sea-lock on the coast at Heyst, and thence of two ship canals with 7 meters = 23 ft. depth of water, one of 12 kilom. = 7½ miles to Bruges, and the other of 50 kilom. = 31¼ miles to Ghent, as proposed by M. de Maere-Limander—is shown to hold out no prospect of financial success.

M. Colson's plan for maritime canals in Brabant‡—from the Scheldt to Brussels, Malines and Louvain—would alter and utilize the existing Willebroeck and Louvain canals, enlarging them to 6¾ meters or 22 ft. depth of water, with 20 meters = 65½ ft. width at bottom and 53¾ meters = 176½ ft. at surface, so as everywhere to allow two vessels to pass. Instead of both canals falling into the Rupel as at present, the Willebroeck or Brussels canal would be prolonged to enter the Scheldt just above the confluence of the Rupel, opposite Rupelmonde; the Louvain canal would join the Brussels canal at a little more than 8 kilom. = 5 miles from Brussels; and a branch of 8.8 kilom. = 5½ miles would connect Malines with the Brussels canal. The distances from Antwerp would be 45 kilom. = 28 miles to Brussels, 61 kilom. = 38 miles to Louvain, and 34 kilom. = 21¼ miles to Malines. There would be five levels, as at present, for the total fall of 10.78 meters = 35½ ft. from Brussels to the Scheldt; and the locks would be 14 meters = 46 ft. wide; with a clear length of 120 meters = 394 ft. A lengthened investigation respecting traffic leads the author to the conclusion that the Brabant plan, besides being easy of execution, will prove from the very first a profitable undertaking, and will largely aid the development of Belgian commerce.

A maritime canal from Liége to the Scheldt with 5 meters = 16½ ft. depth of water, is proposed by M. de Grandvoir, passing through Tongres, Diest, and Aerschot, and joining the present Louvain canal near Campenhout lock. Below this lock both the present canal and the Rupel would want deepening. The distance would be 127 kilom. = 79½ miles by the new canal from Liége to Sennegat, the outlet of the Senne into the Rupel; and from Sennegat to Antwerp 28 kilom. = 17½ miles by river; making a total of 155 kilom. = 97 miles from Liége to Antwerp by water, against the railway route of only 108 kilom. = 67½ miles. The existing Campbine canal from Liége to Antwerp, which takes a longer course northward of the proposed route, would be laid idle by the ship canal. From traffic considerations which he investigates, the author believes the carrying out of the Liége project could not result otherwise than in loss.

Conclusion.—While engineering talent has for half a century past been brought to bear upon the development of the railway system, canals have been almost neglected. The author has aimed at showing the importance of their now receiving very careful attention; he recommends examining the present state of canal navigation in other countries, and watching closely the Canadian ship canals, as well as the ordinary canals in America, particularly the Erie canal. Great results may yet be achieved, he is confident, by the scientific study of canal navigation.

* *Vide* Minutes of Proceedings, Inst. C. E., vol. lxii. pp. 4 and 32.

* *Vide* "Travaux Hydrauliques," No. 174 of Belgian Parliamentary Papers, dated 24th May, 1878, containing detailed descriptions and illustrative plans of the projects for extending the sea commerce of Belgium; Plate 3 represents graphically the statistics here referred to.

† *Vide* "Travaux Hydrauliques," section 1.

‡ *Vide* "Travaux Hydrauliques," section 3.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 80.)

CCCCXCI.—FLATBUSH, N. Y.

Flatbush, on Long Island, N. Y., in lat. 40° 35' N., long. 73° 55' W., adjoins the city of Brooklyn, and is on irregular ground.

Water-works were built for a private company in 1881 by Benjamin F. Stephens, taking the supply from twelve wells, 8 ft. in diameter and 36 ft. deep, sunk in the saturated sand and gravel of the south slope of Long Island. Two compound condensing steam engines pump the water through 2⅛ miles of 20-in. and 16-in. pipe to a stand pipe of plate iron 20 ft. in diameter and 102 ft. high, on a stone foundation 6 ft. above the ground, which is 84 ft. above the pump. The town, which averages 140 ft. below the top of the stand pipe, is between it and the pumps.

Distribution is by 10 miles of cast-iron pipes, of from 20 to 4 in. diameter, with 26 fire hydrants, 60 gates and 150 taps. Service pipes are of lead and galvanized iron. The county pays $7,500 for the water for the county buildings, but the amount to be paid for fire service has not been determined.

The population in 1880 was 7,634. The daily consumption is not given.

The capital stock of the company is $200,000, and the bonded debt $160,000, at 6 per cent. interest. Further financial statements are not given.

Jeremiah Lott is the Superintendent.

CCCCXCII—CONEY ISLAND, N. Y.

Coney Island, New York, a sand beach on the Atlantic coast of Long Island, near the entrance to New York Harbor, became a fashionable summer resort in 1878, when several large hotels were built and a racecourse made. Water was at first supplied from the Prospect Park works, at Brooklyn. In 1880, Benjamin F. Stephens built works for a private company, taking the supply from fifteen wells, from 26 to 46 ft. deep, sunk in the porous sand and gravel of the "main spring" of Long Island. The water is pumped by two steam engines of 1,000,000 gallons daily capacity into a plate-iron stand pipe 20 ft. in diameter and 78 ft. high. It will be made 108 ft. high in 1883.

Distribution is by six miles of cast-iron pipe, of 14 to 4-in. diameter. Service pipes of lead and of iron are used.

The permanent population is very small, but in summer it varies from 2,000 to 100,000. The consumption is similarly variable.

The works cost $100,000, and the bonded debt is $80,000.

B. F. Stephens is the Superintendent.

CCCCXCIII.—GARDEN CITY, N. Y.

Garden City, New York, in lat. 40° 40′ N., long. 73° 45′ W., on Hempstead Plains, on Long Island, on a plateau sloping to the south at the rate of 15 ft. to the mile, was established in 1874, and is maintained by the estate of Alexander T. Stewart.

Water-works were built in 1876 after plans of W. R. Hinsdale, taking the supply from the "main spring" of Long Island. A well 50 ft. in diameter and 35 ft. deep is sunk in the saturated gravel. The water is pumped directly into the mains by a Holly quadruplex steam pump. The ordinary pressure maintained is 50 lbs., and the fire pressure 80 lbs.

Distribution is by 4 miles of cast-iron pipe of from 12 to 4 in. diameter, with 45 fire hydrants, 15 gates and 125 taps. Service pipes are of wrought iron.

The population in 1880 was 800. The daily consumption in 1882 was 750,000 gallons.

The works cost $60,000. No further financial statistics are given.

L. H. Cunliffe is the Superintendent.

CCCCXCIV.—TRAVERSE CITY, MICH.

Traverse City, Michigan, in lat. 44° 45′ N., long. 85° 40′ W., is at the head of Grand Traverse Bay, on Lake Michigan.

Water-works were built in 1881 by H. D. Campbell as a private enterprise, taking the supply from Grand Traverse Bay, 500 ft. from shore in 20 ft. depth of water. On the shore are two settling basins, from which the water is pumped directly into the mains by two Walker steam-pumping engines with 14 in. steam and 8½ in. water cylinders of 12-in. stroke, and with fly-wheels. The engines are arranged to run separately or together, and pump directly into the mains, the water passing first through a "compression chamber" which is an air chamber 4 ft. in diameter and 12 ft. long.

Distribution is by 2 miles of Wyckoff wooden pipe of 8 to 4 in. diameter, with 23 fire hydrants and 12 gates. The number of taps is not given, nor any financial statements.

The population in 1880 was 1,597.

CCCCXCV.—WINCHESTER, VA.

Winchester, Virginia, in lat. 39° 10′, N. long. 78° 10′ W., is on broken ground in the Shenandoah Valley. It was settled in 1752 and incorporated in 1779.

Water-works were built by the city in 1881, taking the supply from a large spring half a mile from and 50 ft. above the city.

Distribution is by 25 miles of cast-iron pipes, with 25 fire-hydrants, 25 gates and 550 taps.

The population in 1880 was 4,958. The receipts for the year ending May 1, 1882, were $3,000. No further information has been furnished.

John H. Nulton is the Superintendent.

CCCCXCVI.—STREATOR, ILL.

Streator, Illinois, is in lat. 41° 10′ N., long. 88° 50. W.

In 1882, an artesian well was sunk 2,496 ft., reaching a vein of saline water in the Potsdam sandstone, which rises to 40 ft. above the ground, and is conveyed in wooden pipes through the city. It is used only for fire protection and sprinkling. There is one-half mile of pipe, with six hydrants. The population in 1880 was 5,157.

CCCCXCVII.—SAN RAFAEL, CAL.

San Rafael, California, in lat. 38° N. long. 122° W., is in the mountains of Marin County, a peninsula lying between the bays San Pablo and San Francisco. Water-works were built in 1871 by the Marin Co. Water Company, a private corporation, taking the supply from a lake of 22 acres area, fed by mountain springs. A wooden flume, 16 by 12 inches, conveys the water 1,500 ft. to a small reservoir built of brick and cement, holding 1,500,000 gallons, 150 feet above the town.

Distribution is by 15 miles of pipe of from 8 in. to ¾ in. diameter. Cast iron, wrought iron and riveted sheet iron are used. There are 22 fire hydrants, 35 gates and 450 taps. Ten meters are in use. The town does not pay for public water. Service pipes are of wrought iron.

The population in 1880 was 2,276. The daily consumption is not given.

The capital stock of the company is $300,000. The works have cost $450,000. The bonded debt is $50,000 at 6 per cent. interest.

The expenses in 1882 were $26,432, and the receipts $33,334.

Robert Walker is Superintendent and F. R. Cotton Secretary.

CCCCXCVIII.—COATESVILLE, PA.

Coatesville, Chester County, Pennsylvania, in lat. 40° N., long. 75° 45′ W., is on the rolling ground on Brandywine Creek.

Settled in 1780, it was incorporated a borough in 1864.

Water-works were built by the borough in 1870, after plans of Isaac S. Cassin, C. E., taking the supply from a number of springs, the water shed feeding which is of 1½ square miles area. A small dam of rubble stone masonry retains the water in a reservoir of 1,000,000 gallons capacity, half a mile from the springs. From this it is conveyed 2,200 feet through 10-in. cast-iron pipe to a reservoir in excavation and embankment near the town, and 121 ft. above it. Distribution is by 4¾ miles of cast-iron pipes of from 12 to 4 in. diameter, with 52 fire hydrants, 76 gates and 411 taps. Service pipes are of lead.

The population in 1880 was 2,766.

The daily consumption in 1882 was about 120,000 gallons.

The works cost $42,000. The bonded debt is $40,000 at 5 per cent. The expenses in 1882 were $475, and the receipts $2,500.

The works are managed by a committee of the borough council. F. F. Davis the Superintendent.

CCCCXCIX.—OXFORD, PA.

Oxford, Chester County, Pennsylvania, in lat. 39° 47 N., long. 75° 55′ W., is on rolling ground on Elk Creek.

Settled in 1840, it was incorporated a borough in 1859.

Water-works were built by the borough in 1869 after plans of Isaac S. Cassin, C. E., taking the supply from Elk Creek, which here has a watershed of 3 square miles.

A crib-dam creates an impounding reservoir and gives head to drive a 14-ft. overshot iron water wheel operating two double plunger pumps, which lift the water 137½ ft. to a reservoir in excavation and embankment holding 1,500,000 gallons at 74 ft. above the principal street. Distribution is by 4 miles of cast-iron pipe of from 8 to 3 in. diameter, with 35 fire hydrants, 39 gates and 300 taps. Service pipes are of lead. The population in 1880 was 1,502. The daily consumption in 1882 was 80,000 gallons. The works have cost $31,000. The bonded debt is $28,000 at 5 per cent. interest. The expenses in 1882 were $500, and the receipts $2,000.

The works are managed by a committee of the borough council. John Reed is the Superintendent.

D.—RED BLUFF, CAL.

Red Bluff, California, in lat. 40° 10′ N., long. 122° 15′ W., is on a terrace of red gravelly loam 60 ft. above the Sacramento River.

Settled in 1850, it was incorporated a city in 1874.

Water-works were begun in 1861 by a private company, but they changed hands frequently, and little was accomplished until 1880, when Gen. C. Cadwalader designed and constructed the present works, taking the supply from Antelope Creek, 8 miles from the city, fed by streams from the Sierra Nevada. A timber dam forms a small impounding reservoir, 100 ft. above the city, whence the water is conveyed through an 8-in. wrought-iron pipe (of No. 16 iron) to the city. A further supply is taken from the Sacramento River in the city limits. The river water, after being settled in a basin, is pumped 100 ft. by two steam pumps made by W. T. Garret, into 4 tanks, of from 45,000 to 55,000 gallons capacity each, at 55 ft. above the city. There is also a stand pipe 8 in. in diameter and 50 ft. high.

Distribution is by 6 miles of double rivetted sheet-iron pipe and wrought-iron pipe of from 7 to 2 in. diameter, with 28 fire hydrants, 28 gates and 400 taps. The city pays $180 per year for use of hydrants. Service pipes are of wrought iron.

The population in 1880 was 2,106. The daily consumption in 1882 is estimated at 500,000 gallons.

The works cost $100,000. No further financial statements are given. C. Cadwalader is Superintendent and F. J. Nugent, Collector.

(TO BE CONTINUED.)

The receipts of statistics as follows is acknowledged with thanks:

From B. F. Stephens, statistics of Flatbush, N. Y., and Coney Island, N. Y., Water-works.

From Robert Walker, Secretary, statistics of San Rafael, Cal., Water-works.

From Isaac S. Cassin, C. E., statistics of Coatesville, Pa., and Oxford, Pa., Water-works.

From F. J. Nugent, Collector, statistics of Red Bluff, Cal., Water-works.

From J. B. Cooke, proprietor, statistics of Colusa, Cal., Water-works.

From Francis Smith & Co., San Francisco, statistics of Watsonville, Cal., Water-works.

From H. P. Clough, statistics of Water-works of Middleton, Ohio.

From J. M. Randall, statistics of Water-works of East Orange, N. J.

From Ozro Meacham, statistics of Brandon, Vermont, Water-works.

WATER-WORKS CAMBRIDGE, MASS.—This city needs an additional water supply, and, according to the plans of City Engineer Wm. S. Barbour, it can be obtained from the Shawsheen River better than any other source.

NATIONAL RAILWAY EXPOSITION ITEMS.

HOW THE PREPARATIONS FOR IT PROGRESS.

Nearly all the space in the main building, although 800 ft. long, 200 ft. wide and with a gallery ½ mile long, is already taken, especially on the first floor. This fact shows the importance of manufacturers and inventors who think of exhibiting making applications without delay. Already tens of thousands of feet have been assigned in the principal annex.

Hon. Lucius Fairchild, President of the Board of Commissioners, is now in Europe, and his high reputation as a representative of the United States Government for many years in Great Britain, France and Spain will greatly aid in increasing the interest already manifested in the Exposition among foreign manufacturers and inventors, and will doubtless insure an extensive exhibit from abroad.

The call for contributions of "antiquities" of railway equipment and appliances has already met with responses from various parts of the United States and Canada and other foreign localities. Several ancient locomotives will be on exhibition and will form exceedingly curious and interesting evidence of the progress which has been made in railway appliances within a short lifetime. For example: a railway officer in Nova Scotia has taken the pains to hunt up for the Exposition what he says are "the first engine and passenger car in America." This engine, which is said to be the second or third built for Stephenson, is certainly a curiosity. A brass plate on the boiler bears the inscription, "Timothy Hackworth, Sheldon, Durham, Aug., 1839." The engineer and fireman are situated one at each end of the boiler, an iron chair being provided each for their convenience, but they have no protection from the weather. The tender is attached to what in modern engines would be the pilot end of the boiler, and the cylinders are situated above the rear driving wheels.

Several very old passenger cars, built before the idea of "decks" was introduced, and differing in many other curious respects from the modern coach, will be exhibited. Also a number of rails taken from the track of a southern railway, where they have been in use nearly fifty years, and which are believed to be the first imported into this country; some queer old "sleepers"—not sleeping cars—of stone, which were the forerunners of the modern wooden tie, sections of rails of various antiquated patterns, lamps used forty years ago, and many other oddities.

An interesting feature will be the extensive exhibit of iron ores from different sections, which will be under the supervision of the Northwestern Association of Iron Ore Producers. A fine collection of copper ores from the Lake Superior region is also being prepared. An excellent idea of the mineral resources of various portions of the country will be obtained from these collections.

The suggestion has been made by one of the intended exhibitors that the Exposition will form an excellent occasion for starting at Chicago a school of technology for the education of the sons of workingmen in the mechanic arts. It is believed that many of the exhibitors of tools, wood-working machinery, etc., would gladly donate a portion of their exhibits for such a purpose, thus forming the nucleus of a complete outfit of the best and most modern appliances. If the exposition should result in the establishment of a great school of this kind, where hundreds of youths could obtain a practical education in metallurgy and the manufacture by the best methods of all the varied appliances and products of industrial science, this alone would be a sufficient recompense for the labor of organizing the great exposition.

The commissioners are highly gratified at the interest which has been awakened among the representative manufacturing establishments in the country and at the high character of the exhibits offered. The advantages to result from the opportunity of taking part in the national display are so fully appreciated that a large amount of money—in some cases running from $1,000 to $20,000—will be expended by exhibitors in arranging and beautifying their exhibits. The exposition will differ notably from all local fairs and industrial exhibitions by being emphatically a representation of vast interests and industries. There will be little that is cheap or useless in the whole vast display. It will worthily represent the railway progress of the nineteenth century.

BRIDGE ON THE NORTHERN PACIFIC.—The Bridge Committee has decided not to wait for the action of the War Department in reference to whether the bridge at Moorhead, Minn., should be built with a fixed or swinging span, but will go on and build the bridge with a swinging span. At the suggestion of Major Allen of St. Paul, Chief of the Department of the United States Engineers, the bridge will be erected with the spans direct across the channel, thus enabling boats to pass up and down in a straight line, not endangering the piers. The driving of piles has commenced.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.

Tribune Building. New York City.

The Engineering News Publishing Company, Proprietor.
GEO. H. FROST, Treasurer.

SATURDAY, MARCH 3, 1883.

EDITORIAL ANNOUNCEMENTS.

Terms of Subscription.—To the United States and Canada, $4 per annum, including postage; all parts of Europe and Mexico, $5, payable in advance. Remittances at the risk of the subscriber, unless made by registered letter or by draft, check or P. O. order, payable to GEO. H. FROST.

Terms of Advertising.—One inch, 12 lines, one insertion, $2; one month, $6.50; three months, $17; six months $30; one year, $50. Special rate for large space and long time will be given on application. Advertisements inserted for less than three months, payable in advance; for longer time, payable quarterly.

Articles for Publication in the current number should be received at the office of publication not later than Thursday morning, and advertisements not later than Friday noon.

Correspondence upon subjects which naturally belong to the province of this Journal is solicited.

CONTENTS.

	PAGE
A Study of the Movement of Sand (*Illustrated*)	97
CORRESPONDENCE: The Flow of Water Through Pipes	98
Gloucester City (N. J.) Water-Works	98
Canal Navigation in Belgium	98
The History and Statistics of American Water-Works	100
National Railway Exposition Items	101
EDITORIAL DEPARTMENT: Notes	112
Engineering in Other Lands	102
Proposed Water-Works, Galveston, Texas	103
Fire Proof Paper and Ink	104
EDITORIAL DEPARTMENT: Statistical Tables of American Water-Works, by J. J. R. Croes	104
Personal	104
Elections and Appointments	104
Railway Improvements in 1882	104
The Weights of Framed Girders and Roofs	106
The Civil Engineer	106
Current Meter Observations in the Tidal Compartment of the Thames	106
The Teleradiophone	106
Blowing up Ice in the Elbe	106
News of the Week	107
The Iron and Metal Market	108

AMERICAN INSTITUTE OF MINING ENGINEERS.—The annual meeting of this society was held at Boston, commencing Tuesday, February 20, and continuing until the following Friday. During the past year 215 members and 16 associate members were elected, the total membership now being 1,213. At the final session the following officers were elected for the ensuing year: President, Robert W. Hunt, Troy, N. Y.; Vice-Presidents (to serve two years), S. F. Emmons, Denver, Col.; W. C. Kerr, Washington, D. C., and S. T. Wellman, Cleveland, O.; Managers (to serve three years), John Birkinbine, Philadelphia; Stuart M. Buck, Coalburgh, W. Va., and E. S. Moffat, Scranton, Pa.; Treasurer, Theodore D. Rand, Philadelphia; Secretary, Thomas M. Drown, Easton, Pa.

TRANSACTIONS OF AMERICAN SOC. C. E.—The contents of the December number, just received, are Discussion on Rapid Methods of Topographical Surveying, by Jas. P. Allen; Weights and Measures, by Fred Brooks, with discussion on same by Jacob M. Clark; On the Care and Maintenance of Iron Bridges, by H. D. Blunden, with discussion on same by Theodore Cooper; A Peculiar Phase of Metallic Behavior, by O. E. Michaelis, with discussion on same by T. Egleston. The number is very copiously illustrated and it also contains title page and index of contents of Vol. VIII. Memoirs of the following deceased members are given: Maximilian Hjortsberg, William W. Wright and Charles W. Howell. The following are the additions to membership published in this number; they were all elected on Dec. 6, 1882: Henry J. Gielon, U. S. Asst. Engineer, Town Creek, Ala.; Edward S. S. Safford, Div. Eng. N. Y., W. S. & B. R. R., Newburgh, N. Y.; James D. Schuyler, Chief Engineer and Gen. Supt. Sinaloa & Durango R. R., Culiacan, Mex., *via* San Francisco and Mazatlan; Thos. W. Spencer, Div. Engineer N. Y., W. S. & B. R. R., Utica, N. Y.; Russell Thayer, Chief Engineer Supt., Fairmount Park, 232 South Twenty-second street, Philadelphia, Pa.; Edmund B. Weston, Engineer Water Dept., Lock Box 1,071, Providence, R. I.; Edward Yorke, Chief Engineer Pacific Line, Mexican Central R. R., Guadalajara, Xalisco Mexico.

The following are changes and corections of address of members: Chas. E. Billin, care of Engineers' Club, 1,528 Chestnut street, Philadelphia, Pa.; Robt. Blickensderfer, Supt. Idaho Div. U. P. R. R., Pocatella, Idaho; Edward Canfield, Supt. South Div. N. Y. O. & W. R. R., Tappan, N. Y.; Casimir Constable, 2,035 Seventh avenue, N. Y. City; Jno. B. Duncklee, 2,136 Pennsylvania avenue, Washington, D. C.; Robert Forsyth, 15 Walton Place, Chicago, Ill.; Oliver L. Glover, Chief Engineer, Salvador Central Railway, La Union, Salvador, C. A.; Chas. Hermany, Chief Engineer, Water-works, 549 Third street, Louisville, Ky.; Afred Noble, 43 Campbell street, Detroit, Mich.; Lafayette Olney, Newburgh, N. Y.; William H. Searles, Beach Creek, Clinton County, Pa.; Jos. S. Sewall, 481 Carroll street, St. Paul, Minn.; Chas. Seymour, Chief Engineer S. E. & S. E. R. R., Palestine, Ill.; William P. Shinn, Vice-President N. Y. Steam Co., 22 Courtlandt street, N. Y. City; Thos. W. Symons, Lieut. Corps of Engineers, U. S. A., Hotchkiss, Tenn.; Sebastian Wimmer, St. Marys, Elk County, Pa. JUNIOR MEMBER: Geo. Burnham, Jr., 500 N. Broad street; Philadelphia, Pa. *Resignations:* Arthur Beckwith, Geo. M. Copeland, Francis C. Lowthorp.

ENGINEERING IN OTHER LANDS.

SEWER AND ROAD TAX IN AFRICA.—That a great deal remains to be done in the engineering line is a fact that nobody can gainsay. This idea occurred to us on reading in the *Journal Officiel* two governmental decrees relating to the more useful and sanitary than æsthetic subject of sewers. One of these laws imposes a special tax on the construction of roads and sewers in Tunis. The tax is not to be levied except where work is really done, and must not exceed 24 francs per yard of fronting on street. The second decree imposes an annual tax for the same purposes, which will vary according to the streets, from 15 centimes to 3 francs 60 centimes per yard of front. That Timbuctoo will yet be blessed with plumbers, and that sanitary engineers may not only live there, but make a livelihood, is one of the things that are within the near future.

FOREIGN IRON TRADE.—It is very likely that a great deal of French and German capital will be "forcedly obliged" to seek investment in the United States and other foreign countries during the present year. There is nothing but liquidations in Paris, and the so-called "banks" are going down like so many card houses. The iron market is in a bad condition. A letter from Maubenge says: "There is a general decline on all kinds of iron; rails have gone down, and the small workshops in the North, which number up into the hundreds, find it difficult to obtain any orders from the large works. This will enable the latter to obtain some first-class workmen. One house that will be especially formidable to the Paris firms is that of Evrard, at Raismes, which is now employing some 2,000 men in turning out railroad rolling stock. Two large houses—the Société Metallurgique Belge and Billet (Valenciennes) are also almost ready for manufacturing railroad bridges and general rolling stock. About one thousand hands will be employed in each. The German works, especially in the neighborhood of Dusseldorf have also plenty of orders from the railroad people.

FLOODS—THEIR CAUSES AND SO-CALLED REMEDIES.—Now that floods have caused such enormous damage and loss of life in this country as well as abroad, renewed attention will be given to the subject, which becomes an imperative one. Some time ago we translated an article from the *Annales des Ponts et Chaussées*, showing the utter futility, as observed in the French inundated districts, of endeavoring to overcome the disastrous consequences of the rise of rivers by any system of dams or cut-offs, unless the latter had separate outlets. The upper Loire is especially liable to inundations, and the subject of diminishing the damage has been long under consideration. Enrockments, fascine works, plantations, etc., on the one hand, and dikes, levees, stone dams, on the other, have all been tried and found more or less wanting. Such a river as the Loire, says *Les Annales des Travaux Publics*, has an essentially torrential system. The freshet is phenomenal in its suddenness, and this explains to a certain extent the sharp slopes of its banks. The valley of the Loire may be said to cover some 150,000 acres, and the average incline of the *thalweg* is about 42 in. per 1,000 yards. The river bed is composed of gravel and pebbles from the mountains, or from the wearing of the banks. These form into sand banks, and with the velocity of the current, etc., constitute a difficult problem for the engineer who wishes to protect the riparian property. The average width of the *usual* bed is about 110 yards, but that of the full river (*pleniosimum flumen*) is fully double, while that of the "inundatable" valley is almost one mile.

At one place where the Loire and the Lignon meet—the latter bringing in 500 cubic yards per second in times of flood—the height of the waters is far above the calculation; this is owing to the fact that the principal current of the Lignon strikes that of the Loire in such a way as to slacken the respective velocities of both rivers, and thus produce what might be termed a "swelling," or backwater, thus placing the southern part of the valley in a most critical position. The danger is moreover intensified by a transverse dike, which has been built by another syndicate on the right bank, and which throws the principal current of the flood onto the other bank.

All the earthworks that have been built prior to 1878 and in accordance with the timorous advice of the interested parties have been destroyed or rendered completely useless by the freshet. The great remedy was to raise the levee so as to render it practically unsubmergible. But the breaks in the levee soon proved the utter futility of such devices, for the land was cut up into ravines and filled with sand and gravel. It thus became evident that every attempt to restrict the water field of the two rivers only increased the rise and the danger of the levee being submerged by the freshets. When an attempt was made to gauge this rise it was found that there were no certain data to work on. Besides (and this fact has been amply attested in our own recent floods) even if the highest level of former floods is known, who can say that a higher cannot be reached another time and that such was the *certain maximum?*

Up to 1878 the great "salvation" method was to raise the levee, but this only increased the evil, as the transverse profile of the dike was not adapted for drawing off the water.

The talus of the land sides had too sharp an incline (3 base to 1 in height) to resist the washing effect of the water, however well they might be protected by "sods" of earth. But to give a slope that would be slight enough and to have the levee sufficiently wide at top and of a sufficient height would require an enormous increase in the cubic volume of the earthwork.

The engineers had a great deal of difficulty in having a submergible levee accepted. The works comprised a levee and bank enrockments. The former was reseed and lengthened toward down stream. The longitudinal profile of the dike had its crown lowered to three metres above the water-mark, or to the level of ordinary freshets with a slope corresponding to that of the *thalweg* itself. Some parts had other changes, but in general there is a levee, the height of which above water-mark decreases from up stream toward down stream, so that the lands are submerged either from backwater, or, at least, the levee is equally submerged throughout.

The transversal profile has a width at top of two metres, a talus of 2 base to 1 of height on the side of the Lignon and Loire, and a talus of 8 base to 1 of height on the land side. All the talus and copings were sown with a mixture of rye grass,

sainfoin and red clover; 100,000 osier shoots were planted at the base of the talus on the land side for a width of ten metres. They have proved very efficacious in lessening the speed of the water and in forming new and strengthening deposits at the levee approaches.

The enrockments are composed of stockade fascines and rubble enrockments. The former were built parallel to the axis of the streams with the view of reconstructing the banks where they had been eaten into by the current. The banks have been retained as far as possible, but sharp points were taken away. The works may be considered on the whole as a regularization and consolidation of the river banks, and although there have been several risings of the river, there has been no break in the levee, and the lands have not been cut up by lateral currents. The idea was, that it is better to receive great floods by *colmatage* (filling the marshes with soil) than to oppose them with obstacles that are only reputed insurmountable.

But a writer in the *Chronique Industrielle* reprints a communication which he addressed nine years ago to the *Académie des Sciences*, on the best way of preventing inundations. He has no faith in planting trees for the purpose, and points to our own experience in the matter. His idea is to have flood-gates at the principal sources, so as to control their outpour, and he cites what is done in this way at Saint Ferreol, a reservoir which feeds the Canal du Midi. Enormous stop-cocks and sluices completely control the water supply. "Suppose the same method applied to any of our hydrographic basins, and a too rapid thaw of snow or excessive fall of rain to take place. The persons in charge would only have to close the sluices more or less, and the running streams thus impoverished would give room to the torrential waters, which would thus pass off without further damage." He thinks that rivers can be governed only at their sources, and that much of the excessive water there in winter might be let off advantageously in summer. The author says his calculations on the subject were destroyed during the war of 1870, but believes that the experiment should be made on a certain scale.

A paper on the same subject, in so far as regards the Vienna basin, was read lately before the Austrian engineers. The author, Herr Klunzinger, mentions Lauterberg's work on Swiss rivers, their capacity of drainage, and the various calculations that may be made; absorption, rapidity of current, etc. There are now two problems, in fact, which the engineer of the present has to solve—he must either insure an outlet for a maximum high water of a river for several miles within a certain vaulted space, *or else, by the building of reservoirs, endeavor to partly utilize this high water, and hold it back in such a way that no more water will come to seek an outlet than the discharge* profile below can take.

The downpour in the basin must be known and provided for, and until there is an exact determination of the connection between cause and effect in this line, very little can be done by the artificial change of the natural condition or the discharge. But we must ascertain the *rapidity* and the *quantity* of the various feeders to the streams, and the quantity of the rainfall. Observations made in the Vienna district showed that 38.3 per cent. of the rainfall was retained in May, in July 63 per cent. This fact of the difference in the quantity and velocity of the rainfall in different years leads the writer finally to the conclusion that by dividing into zones that would be in telegraphic communication, the overflow might be regulated. While there is much ingenuity in these methods, it is evident that they could hardly be applicable to the immense stretches of our country, and that the thaw of snow, etc., being almost equal throughout vast distances, there would be difficulty in holding back such water, the more so as the snow-water escapes in very insidious ways.

ST. BERNARD TUNNEL.—The piercing of the St. Bernard is now receiving that amount of attention which is a necessary preliminary to the serious discussion of such great works. And this is, in fact, owing to the best of all reasons, the insufficiency of the St. Gothard.

PASTEUR'S THEORIES.—It is almost a necessity now for sanitary engineers to study the writings and discoveries of M. Pasteur. He found the septic vibrion in common water in 1878—this little workman of death is out of range of the engineer, however.

A COMMISSION for disposing of the Sewage has just been appointed by the Paris Council. It is composed of a large number of prominent engineers. In a recent work on the *odeurs de Paris*, M. Jules Brunfaut, civil engineer, is in favor of an open canal from Paris to the sea—all bordered with the Australian eucalyptus, the melancholy vegetation of which could hardly render the surroundings very æsthetic. He would want the sewers at the same time to be regularly scoured out by having a branch of the Loire turned into them—heroic remedies in one sense.

PROPOSED WATER-WORKS, GALVESTON, TEXAS.

Mr. J. D. Cook, C. E., of Toledo, who is consulting engineer to the Water Supply Committee of Galveston, Texas, has submitted his report concerning the water supply of that city. The problem he has endeavered to solve is outlined by the following heads:

1. The feasibility and cost of a system of works to supply the entire city with salt water for fire protection.
2. A salt water system covering that portion of the city between Eighteenth and Thirtieth streets, and Avenues A and G, both to be supplied by pumping-works on Galveston Bay.
3. A fresh water supply, suitable for all purposes.
4. Comparison between standpipe and direct pressure service.
5. The comparative policy of constructing and operating works by the city and by a private or a corporate company under a franchise contemplating the payment to said company by the city of a stipulated annuity for water for the extinguishment of fires and for other public uses, the city reserving the right to purchase the works during the life of the franchise, or after its expiration.

These, in connection with the consideration of the most eligible source of fresh water supply, form the elements of the problem. The nearest and least expensive supply could be obtained from the island itself, the drainage from an area of about nine square miles being available. Only a comparatively small portion of the whole area of the island could be used, and as the surface is higher along the gulf coast—descending toward the bay—levees would have to be built along the northern boundary of the water-shed beside several others to prevent the inflow from the gulf. Another difficulty is presented by the fact that the soil generally is of such material as to readily permit the permeation of salt water, as is evidenced by the wells now in use, and even should all surface entrances to the reservoirs be closed, they might be contaminated by seepage from the gulf or bay. While it is stated that an acceptable supply might be obtained from the rainfall on the island, a failure would result in total loss, and the plan is not recommended.

The next and only source is in some one or more of the bayous traversing the mainland north of Galveston Bay. The Highland Bayou has a water-shed of 35 square miles that could be utilized, and would give an ample supply for many years; and, if necessary, an addition could be readily obtained from the water-sheds of Dickinson Bayou and Clear Creek, thus adding the drainage from more than 100 square miles. This plan is recommended. To do this, it is proposed to build a gathering reservoir by excavations on each side of the bayou channel. The length would be 10,000 ft. and the width 300, the excavated material to be used in constructing four storage reservoirs, each 500 ft. wide by 2,000 ft. long. The dam of the gathering reservoir would be 8 ft. high from crest to bottom; the banks of the storage reservoirs would be 20 ft. above the surface of the gathering reservoir and the depth of water would be 16 ft., giving a capacity of 150,000,000 gallons in the former and 450,000,000 in the latter. Allowing for 150,000,000 gallons lost by evaporation during four months' drought, this would give 450,000,000 gallons, which would give a supply of 3,750,000 gallons per day during that time, or 50 gallons per capita per day for a population of 75,000.

The storage reservoirs being built of earth taken from the others, the greatest capacity is obtained with the least outlay. To illustrate this, it would require an excavation of 2,000,000 cubic yards to obtain the same capacity, incurring an extra cost of nearly $500,000. Pumping machinery to raise the water from one reservoir to the other would not exceed $50,000; the interest on this and the yearly operating expenses is $5,500, while the interest on $500,000 is $30,000. Reservoirs placed as described would give an abundant supply of pure, clear and soft water.

From the reservoirs to the proposed pumping station near the westerly line of the city is about 39,000 ft., including the bay at 12,000 ft. Water can be brought to the city by a brick conduit with cast iron pipes across the bay, or by a cast-iron pipe the entire distance, or by pipe made of hard pine timber bound with iron, excepting under the bay, which should in either case be of cast iron. A 48-in. circular pipe under a head of 20 ft. would deliver 17,500,000 gallons every 24 hours; a 36-in. pipe, 8,500,000 gallons.

The cost of a 42-in. brick conduit, 27,000 ft. long, and a 48-in. pipe, 12,000 ft., would be approximately	$420,000
All cast iron pipe of same length and diameter	500,000
Wood and iron	235,000
Substituting 36 in. diameter, would reduce the cost of all iron to	340,000
Of brick and iron	320,000
Of wood and iron to	168,000

Mr. Cook states that wooden conduits are in successful service elsewhere, and when properly laid and protected would seem to be safe and practically permanent. The natural flow through the 36 inch pipe would be sufficient for some years, and its flow could be safely doubled at any time by working the low-service pump into it. This would necessitate the use of cast-iron pipes, which may perhaps be taken as the most permanent and reliable arrangement.

A map and table show the locations and sizes of pipes, valves and hydrants.

The pumping machinery for raising fro gathering to storage reservoirs should consist of two or more pumping engines, with an aggregate capacity of 20,000,000 gallons per day, against an extreme head of 30 ft., and three return tubular boilers, each 5 ft. diameter and 16 ft. long. The pumping service in the city should consist of one compound condensing engine, capacity of 5,000,000 gallons to a height of 200 ft., and able to work against a pressure of 125 lbs. per square inch; and one non-compound, non-condensing engine, capable of pumping 2,500,000 gallons under same conditions; also five boilers similar to above. A standpipe having an internal diameter of 25 ft. and a height of 200 ft. is recommended, to be placed upon a foundation of first-class masonry.

The question of protection from fire by a water supply and the consequent reduction in the amount of premiums paid is dwelt upon. In regard to the scheme of taking salt water for this purpose, the report states that there are abundant and demonstrable reasons for serious doubt. The average quantity of water used for the extinguishment of fires in American cities is less than two per cent. of the entire quantity pumped.

A standpipe of large capacity and adequate height is considered a very important adjunct to the system and its many advantages are enumerated. The pipe suggested for the works would contain 736,500 gallons, of which 552,400 gallons would be above an altitude of 50 feet, and which would furnish the night supply for some years, thereby permitting the pumps to rest one-half the time. For fire service this large quantity of water held in store would nearly double the capacity of pumping machinery and "practically quadruple the efficiency of your works in point of actual safety. For instance,

with the standpipe full, and the machinery at rest, you could throw ten one and one-eighth-inch fire streams through 100 feet of hose to a maximum altitude of 120 feet—a minimum of 80 feet—and an average altitude of 100 feet, for two hours, reducing the surface of water in pipe to 125 feet or ten one-inch streams under same conditions, two hours and thirty minutes, or for one-half the time—usually the most critical period of a conflagration—double the number of streams."

The relative merits of the two methods of securing water-works—built, owned and governed by the city or by a private company—are discussed.

Although there are other estimates given in the report, we present the one which is considered by Mr. Cook as first-class in every particular:

5,040 tons of pipe laid, distribution A	$287,000
90 tons of special castings	5,400
360 hydrants set	18,000
358 stop-valves set	10,048
Gathering and storage reservoirs and appurtenances	252,180
Standpipe, 25 ft. diameter, 200 ft. high, and foundation	70,000
Engine-houses	17,000
Pumping machinery and pipe connections	100,000
36-in. main from reservoirs to Fifty seventh street, about 30,000 ft., all iron	340,000
	$1,099,628
Add for real estate, engineering, incidentals and omissions	30,372
Total	$1,130,000

An estimate for salt water-works is as follows:

4,300 tons of pipe laid	$206,000
80 tons of special castings	4,800
300 hydrants set	15,000
Valves set	9,000
Standpipe, 25 by 200 ft. and foundation	70,000
Engine-house and smoke-stack	12,000
Pumping machinery and connections	60,000
	$376,800
Add for engineering, real estate, incidentals and omissions	23,200
Total	$400,000
Less standpipe	70,001
Total	$330,000

STATISTICAL TABLES OF AMERICAN WATER-WORKS, BY J. J. R. CROES, M. AM. SOC. C. E., M. INST. C. E.

It is two years since we entered upon the compilation of the "History and Statistics of American Water-Works." Mr. Croes, one of the most industrious and indefatigable of workers, gave himself one year for the task. There are about 700 places in the United States and Canada that have a public water supply; we have published the history and statistics of 500, and it seemed sometimes as if we would not be able to reach even that number. The amount of labor and study involved in these two years' work of Mr. Croes, no one who has not already been "through the mill" can appreciate. The end is drawing near. During the coming summer Mr. Croes will plan his work for the reprinting in book form, of the material accumulated, and as soon as it can be accomplished the volume will be issued. But the work to be done is very great and will take a full year to complete. We will feel well satisfied if the book is ready for sale by the middle of 1884.

Meanwhile Mr. Croes has tabulated the statistics accumulated, and we are pushing the publication in pamphlet form as energetically as possible. A very handsome pamphlet of about 150 pages will be issued, if possible, before the close of this month. It will consist of about 104 pages 6 by 9 inches in size, of statistical information relating to water-works from which Mr. Croes has returns up to the date of last "copy" going to the printer. It is set in leaded long primer type, so as to be easily read, and printed on a fine quality of book paper, with handsomely illustrated covers.

The matter is arranged under the following heads: No. in Statistics; No. in History; Name of Town, State or Province; Population in 1880; Date of Construction of Works; By Whom Owned; Source of Supply; Mode of Supply; Builders of Pumping Machinery; Cost of Works; Bonded Debt; Rate of Interest; Officers of Works; Year of Returns; Expenses; Receipts; Daily Consumption in Gallons; Miles of Pipe; Sizes of Pipe; No. of Taps; Daily Consumption per Tap; No. of Meters; No. of Fire Hydrants; Annual Price per Hydrant by City; Kind of Pipe in Mains and Service. The information embodied in this publication is the most complete system of water-works statistics ever published in any country, and must prove a book of constant reference to every person or corporation interested in public water supply, its construction and maintenance.

The pamphlet has been a very expensive one to publish, and would not have been undertaken at all but for the liberal support of a large list of advertisers. Notwithstanding this generous patronage we will not "get out even" after all the bills are paid. The following individuals and firms have contracted for the whole, or portions of a page each:

GLOUCESTER IRON WORKS, Gloucester, N. J.
PEET VALVE CO., Boston, Mass.
JAMES MARSHALL & CO., Pittsburg, Pa.
WARREN FOUNDRY AND MACHINE CO., New York City.
UNION WATER METER CO., Worcester, Mass.
HOLLY MANUFACTURING CO., Lockport, N. Y.
BOSTON MACHINE CO., Boston, Mass.
JONSON FOUNDRY AND MACHINE CO., N. Y. City.
THE EDDY VALVE CO., Waterford, N. Y.
HENRY R. WORTHINGTON, N. Y. city.
LUDLOW VALVE MFG. CO., Troy, N. Y.
THE BELL WATERPHONE CO., Cincinnati, O.
CHAPMAN VALVE MFG. CO., Indian Orchard, Mass.
THE NEWARK FILTERING CO., Newark, N. J.
CINCINNATI AND NEWPORT IRON AND PIPE CO., Newport, Ky.
GEO. F. BLAKE MANFG. CO., New York City.
KNOWLES STEAM PUMP CO., New York City.
NATIONAL WATER METER CO., New York City.
RUSSELL & ALEXANDER, Colorado Springs, Col.
CARROLL F. GRAY, St. Louis, Mo.
KNIGHT & BONTECOU, Kansas, City, Mo.
BENJAMIN F. STEPHENS, Brooklyn, N. Y.
STEPHEN E. BABCOCK, Amsterdam, N. Y.
JOSEPH EDWARS & CO., N. Y. City.

Three thousand copies are being printed for sale and free distribution. A copy will be mailed free to every water-works official who has furnished information, and advertisers also are entitled to free copies. On account of the great cost of the publication, a price much below the cost of manufacture, without counting anything for labor, will be asked for remaining copies; this price is 30 cents. It is intended that copies will go into every water-works office in the Union and Canada, and wherever works are contemplated. The book must at once become a handy work of reference on water-works statistics, and as such it is of value as an advertising medium, both for parties supplying materials, or for engineers seeking the business of planning and superintending construction of new works. We are certain that the small investment will prove a good one to all advertisers. The prices are:

For ¼ page, 4 in. wide, 1⅝ in. long $15 00
For ½ page, 4 in. wide, 3¼ in. long 25.00
For full page, with cuts, 4x6½ in. 40.00

Payable on delivery of pamphlet containing the advertisement. On application, a circular sheet with a blank contract will be mailed to any applicant. Copy should all be in by the 15th of the month, as we hope to have the last forms ready for the press by that date.

We respectfully solicit the advertisement of every water-works contractor and engineer.

FIRE-PROOF PAPER AND INK.

[Translated from "La Genie Civil."]

A paper which is incombustible at a temperature of 1,700° Fahr., and when exposed to such a degree of heat will still preserve the matter written or printed upon it, is certainly a desideratum. It is claimed in the "Industrié Zeitung" that such a paper has been invented, and we give below the method of manufacture.

Asbestos fibre of the finest quality is washed in a solution of permanganate of potash, and then bleached in sulphuric acid; 95 parts of this asbestos are then mixed with 5 parts of wood fibre, prepared as for paper making; by using water charged with glue and borax, the mass is then reduced to a fine pulp, and the paper manufactured by ordinary methods. It is claimed that a fine writing paper is the result.

To make a fire-proof printing ink, 10 parts of chloride of platinum and 25 parts of oil of lavender are used; the chloride is first heated in a porcelain crucible until perfectly dry, and the oil then added, and the mixture again heated until the vapor ceases to arise; lampblack and printer's varnish are now added in small quantities. When the paper impressed with this ink is burned, the chloride is reduced to a metallic state, and the impression remains as a brown film.

For writing ink use 5 parts chloride of platinum (dry), 15 parts oil of lavender, 15 parts Chinese ink, 1 part gum arabic and 64 parts water.

Fire-proof colors can also be made by mixing the metallic colors employed on porcelain with the chloride of platinum and printing or lithographic varnish; any ordinary color can be added to increase the intensity; 45 parts of cobalt blue, 14 parts ultramarine (water color), 2 parts chloride of platinum and 39 parts of printer's varnish, will make brilliant blue ink, also fire-proof.

PERSONAL.

The Chicago *Times* of Feb. 28, says: "JOHN C. JAMES, Chief Engineer of the Canadian Pacific road, died at Winnipeg yesterday." We believe that Mr. Reed, formerly of Joliet, Ill., is Chief Engineer of the above road.

GEORGE B. MELENDY, Civil Engineer, died on the 24th ult., at his residence, 160 West Fiftieth street, this city. He was born in Amherst, N. H., about 56 years ago, and had lived in this city about 35 years.

Mr. U. G. STRINGFELLOW, Division Engineer of the Mexican National Railroad, died of small-pox at Salvatierra, Mexico, recently. He was a native of Ada, Ohio, and had been in charge of his division of the road since October last; was 26 years old, and had a wife, who still resides in Ohio. He was employed on the New York, Chicago & St. Louis road before going to Mexico, and was highly esteemed by his associates.

ELECTIONS AND APPOINTMENTS.

THE GAS ENGINEERS.—The New England Association of Gas Engineers has elected officers as follows: President, A. B. SLATER, of Providence, R. I.; Vice-Presidents, M. S. GREENOUGH, of Boston, and J. P. HARRISON, of Hartford, Conn.; Directors, A. M. MORTON, of Nashua, N. H.; S. G STEVENS, of Pawtucket, R. I.; WM. YORK, of Portland, Me.; J. S. HALLETT, of Springfield, Mass.; C. H. NETTLETON, of Birmingham, Conn.; Secretary and Treasurer, GEO. B. NEAL, of Boston.

THE officers of the International Construction Company, of Mexico, are: President, C. P. HUNTINGTON; Secretary and Treasurer, J. E. GATES; agent in Mexico, JOHN B. FRISBIE; Chief Engineer, ROBERT B. GORSUCH; Chief of Construction, JOHN B. CONVERSE.

Mr. W. B. BROWN is Chief Engineer of the Meherrin Valley Railroad; office at Margarettsville, N. C.

Mr. J. M. RICHARDSON has been appointed engineer of the New York, Chicago & St. Louis Railroad.

RAILWAY IMPROVEMENTS IN 1882.

(From the Railway Review).

Arizona Territory.

Clifton & Southern Pacific.
Arizona Central.
Arizona Narrow Gauge.
Tucson & Gulf of California.

North Carolina.

Meherrin Valley; from Margarettsville, N. C., to Clarksville, Va. May 15.

Roane Mountain; from the terminus of the Roane Mountain R. on the line between North Carolina and Tennessee to the mines of the Roane Mountain Steel & Iron Company. July 8.

Texas.

Texas-Mexican Northern; office, Laredo; capital, $100,000; termini, Laredo and Eagle Pass; through the counties of Webb, Dimmit and Maverick. Feb. 22.

Rio Grande & Pecos; office, Laredo; capital, $500,000; length, 500 miles; termini, Brownsville and mouth of Pecos River. March 3.

El Paso & White Oaks R. Co. of Texas, and Telegraph & Express Co.; office, El Paso; capital, $500,000; length, 20 miles; termini, El Paso and

State Line of Texas and territory of New Mexico; through County of El Paso. March 29.

Marshall & Northwestern; office, Marshall; capital, $660,000; termini, Marshall and Mount Pleasant; through the counties of Harrison, Marion Upshur, Morris, Camp and Titus. March 29.

Denver & New Orleans; office, Oldham County; capital, $1,000,000; termini, Canadian River, in Oldham County, 15 miles west of Tascosa, to a point on boundary line of State of Texas and territory of New Mexico; through the counties of Oldham and Hartley, near the northeast corner of the county of San Miguel, in said territory, being the southern termini of the Denver & New Orleans R., now being constructed from the city of Denver. Sept. 30.

El Paso & New Mexico; office, El Paso; capital, $400,000; length, 20 miles; termini, El Paso and State Line; through El Paso County. Oct. 24.

Galveston, Sabine & St. Louis; office, Longview; capital, $450,000; termini, Galveston and a point on Red River, in Grayson County, Texas, through the counties of Galveston, Chambers, Jefferson, Orange, Jasper, Newton, Sabine, San Augustine, Shelby, Panola, Rusk, Harrison, Gregg, Upshur, Camp, Wood, Franklin, Hopkins, Delta, Lamar, Fannin and Grayson. Dec. 18.

California.

Bodie & Benton Railway & Commercial Co.; office, San Francisco; length, 80 miles; from Mono Lake to the town of Bodie, in Mono County, and a branch line from south end of Mono Lake to a point connecting with the Carson & Colorado R. near Benton in Mono County. Directors, R. N. Graves, A. J. Ralston, H. M. Yarrington, T. Menzies, W. Willis, J. B. Low, W. S. Woods. Jan. 24.

Presidio & Ferries; office, San Francisco; length, 7 miles; streets of San Francisco; directors, A. W. Bowman, R. Watt, J. G. Kittle, A. S. Hallidie, A. Miller, N. J. Brittan, J. Moffit. Jan. 6.

Baja California & Sonora; offices, San Diego, Cal., and City of Mexico, Mexico; length, 16 miles; from the Bay of San Diego in the State of California to a point of connection with the Baja California & Sonora R. in Mexico, in the Valley of Tia Juana, at or near the boundary line between California and Baja California, Mexico; directors, T. L. Rogers, Y. Alas, W. C. Kimball, J. S. Gordon, M. A. Luce. Feb. 11.

Pacific Coast; office, San Francisco; length 80 miles; from the southern terminus of the San Luis Obispo & Santa Maria Valley R. to the City of Santa Barbara; directors, W. Norris, C. Goodall, E. Goodall, J. Rosenfeld, J. L. Howard. April 18.

Telegraph Hill; office, San Francisco; length, 4,000 ft.; streets of San Francisco; directors, F. O. Layman, G. Sutro, C. Denerrand, M. Gray, D. E. Mellis, O. H. Frank, H. D. Coggswell. May 13.

Pacific avenue; office, Santa Cruz, Santa Cruz County; length, 3 miles; streets of Santa Cruz; directors, R. M. Garratt, C. Hoffman, R. I. Pierce. E. J. Cox, J. P. Pierce. March 3.

San Joaquin & Sierra Nevada; office, San Francisco; length, about 70 miles; from a point in San Joaquin County, at or near where the slough known as Otter or Hog slough empties into the south fork of the Moquelumne River, and thence passing through San Joaquin County and Calaveras County to a point at or near the grove of big trees in Calaveras County. March 28.

Market Street Cable; office, San Francisco; length, 13 miles; streets of San Francisco; directors, L. Stanford, C. Crocker, C. F. Crocker, W. V. Huntington, N. T. Smith. May 20.

Stockton & Mount Diabolo; office, Stockton, San Joaquin County; length, 40 miles; from Stockton in San Joaquin County to Mount Diabolo in Contra Costa County; directors, A. C. Paulsell, J. L. Beecher, J. R. W. Hitchcock, G. H. Castle, I. R. Wilbur, S. Dunham, D. Harrison, J. M. Garwood, L. M. Morse, J. W. Ferris. June 29.

Winters & Ukiah; office, San Francisco; length, 105 miles; from Winters in Yolo County, there connecting with the Vaca Valley & Clear Lake R., and running thence northwesterly up Berryessa Valley to Clear Lake and thence to Ukiah, in Mendocino County; directors, S. T. Gage, N. T. Smith, A. Lathrop, J. L. Willcutt, E. H. Miller, Jr. June 30.

Omnibus R. & Cable; office, San Francisco; length, 8 miles; streets of San Francisco; directors, P. J. McGlynn; T. W. Johnston; W. D. O'Sullivan, G. Lowenberg, G. W. Beaver, R. H. Lloyd, E. W. McCarthy. July 27.

San Bernardino & Colton; office, San Bernardino, San Bernardino County; length, 5 miles; from the town of San Bernardino to the town of Colton in same county, thence to a point westwardly from San Bernardino at or near the depot of the California Southern R., thence to the point of beginning. Directors, J. G. Capron, J. C. King, W. Wilson, W. H. Sloan, C. F. Roe, W. E. Van Slyke. Aug. 14.

Loma Prieta; office, San Francisco; length, 5 miles; from Aptos, in Santa Cruz County, to the confluence of Aptos Creek with the creek running from White's lagoon. Directors, G. Crocker, A. C. Bassett, N. T. Smith, J. L. Willcutt, A. Sanborn. July 10.

California & Yosemite Short Line; office, Bennettville, Mono County; length, 220 miles; from Modesto in Stanislaus County, through Stanislaus, Tuolumne, Mariposa and Mono counties, via Lee Vining Creek or McLean's Pass to the line between California and Nevada, near the Deep Wells in Mono County; directors, J. C. Kemp, O. H. Brooks, R. W. Woolard, C. W. Curtis, F. Kemp. July 10.

Garzas Creek; office, San Francisco; length, 5 miles; from a point at or near the mouth of Garzas Creek, on shore of Pacific Ocean, in San Mateo County, to the Garzas mills, on Garzas Creek, in said county. July 24.

American Colony; office, Los Angeles, Los Angeles County, Cal.; length, 3 miles; from a point on the San Pedro & Los Angelos Railroad, in Los Angeles County, to and through the American Colony tract on the Rancho Los Cerritos, and through the streets in Willmore City on said rancho; directors, R. M. Widney, G. Sinsabaugh, J. S. Slauson, G. F. McLellan, A. M. Hough. Aug. 30.

Elk River; office, Mouth of McLoud's Creek; length, 8 miles; from the town of Bucksport, on Humboldt Bay, to mouth of McLoud's Creek, a tributary of the South Fork of Elk River; directors, C. G. Stafford, N. H. Falk, I. L. Harpster, J. C. Hawley, B. Pendleton. Oct. 27.

San Francisco & San Rafael; office, San Francisco; length, 6 miles; from the junction of the San Francisco & North Pacific R., on Tamalpais avenue, in the town of San Rafael, to a point at or near Tiburnon Point, on Raccoon Straits, in Marin County; directors, P. Donahue, J. M. Donahue, A. Hughes, T. I. Bergin, T. Donahue. Oct. 21.

Eel River & Eureka; office, Eureka, Humboldt County; length, 40 miles; from the east line of T. 1 N. R. 2. E., H. M., on the Van Duzen river, to the city of Eureka; directors, W. J. Sweasey, W. Carson, J. W. Henderson, J. Russ, H. H. Buhne, J. Vance, A. W. Randall. Nov. 14.

Fresno Street; office, Fresno, Fresno County; length, 6 miles; streets of Fresno; directors, E. A. Roe, D. R. Shafer, W. F. Rowe, L. Davis, J. A. Graham. Nov. 13.

Humboldt Bay & Eel River; office, San Francisco; length, 25 miles; from a point on Humboldt Bay, at northeast corner of southwest quarter section 25, town 4 north, range 2 west. H. M., to the southwest quarter section 15, town 1 south, range 1 east, H. M.

North Pacific Coast R. Extension Co.; office, San Francisco; length, 5 miles; from a point on line of North Pacific Coast R., known as Corte Madera Station, in Marin County, to Sancelito, in same county; directors, J. D. Walker, T. Menzies, D. Nye, F. B. Cotton, D. F. Tillinghast. Dec. 6.

National City & Cajon Valley; office, National City, San Diego County; length, 25 miles; from National City, in an easterly and northerly direction to the base of Cajon peak, in Cajon valley, in San Diego County; directors, J. B. Steele, F. A. Kimball, W. C. Kimball, H. E. Cooper, E. T. Blackman. Dec. 23.

New Mexico.

New Mexican; to cover what is not already covered by Atchison, Topeka & Santa Fe system.

Oregon Mountain; to Las Cruces.

El Paso & White Oaks.

Silver City, Deming & Pacific; Deming to Silver City and beyond.

Lordsburg & Clifton; Lordsburg, N. M., to Clifton, Arizona.

El Paso & New Mexico; to coal fields of Lincoln.

Las Vegas & Gulf; Las Vegas to Rio Pecos.

Iowa.

Mississippi, Mount Pleasant & Missouri; office, Mt. Pleasant.

Iowa & Northern; office, Newton.

Keithsburg, Grinnell & Dakota; office, Des Moines.

Oskaloosa, Dallas, Newbern & Southwestern; office, Newbern.

Spirit Lake & Western; office, Sibley.

Fort Madison & Illinois R. & Bridge Co.; office, Fort Madison.

Cedar & Marion; office, Cedar Rapids.

Iowa R. & Construction Co.; office, Garner.

Newton R. Construction Co.; office, Newton.

Wisconsin, Iowa & Nebraska; office, Marshalltown.

Davenport, Iowa & Dakota; office, Davenport.

New Sharon & Mississippi River; office, New Sharon.

Minneapolis, St. Paul & Seacoast; office, Clinton.

Cherokee & Sioux Valley; office, Cherokee.

New York & Council Bluffs; office, Council Bluffs.

Anderson Bros. Mining & R. Co.; office, Monroe.

Missouri Valley & Blair R. & Bridge Co.; office, Cedar Rapids.

Washington, Marengo & Northwestern; office, Washington.

Des Moines, Sac City & Dakota; office, Sac City.

Toledo, Oskaloosa & Western; office, Des Moines.

Florida.

Jacksonville & Palatka; from Jacksonville to Palatka & Indian River; through Duval, Clay & Putnam counties; capital, $2,200,000; directors, M. Young, New York; R. H. Mason, Palatka; A. B. Mason, Chicago.

Florida Central & Western; from Jacksonville to Chattahoochie on the Apalachicola River; through Duval, Baker, Columbia, Suwanee, Madison, Jefferson, Leon and Gadsen counties; capital, $3,000,000; office, Jacksonville; directors, Sir E. J. Reed, London, Eng.; W. MacVeagh, Philadelphia; the said Reed and the said MacVeagh jointly; H. Amy and W. Hinchman, New York; C. S. Hinchman and W. T. Carter, Philadelphia.

Ferry Pass; through Escambia County; capital, $10,000; directors, W. D. Chipley and G. A. Stanley, Pensacola; E. F. Skinner, Escambia County.

Indian River and Manatee; through Brevard, Orange, Polk and Manatee counties; capital, $1,000,000; directors, J. E. Hartride, Jacksonville; A. E. Willlard, Cincinnati, O.; J. E. Yonge, Pensacola; L. G. Leslie, Tampa.

Live Oak and Rowland's Bluff; through Suwannee County; directors, J. F. White, D. M. McAlpin, A. O. Shod and W. B. Taylor, Live Oak; W. P. Hardee, H. M. Drane and H. S. Haines, Savannah, Ga.; J. C. Reynolds, Waycross; G. W. Haines, Jacksonville.

Seville & Halifax River; through Volusia County; capital, $50,000; directors, W. K. Leate and T. W. Wilson, Seville, Volusia County; R. P. Paulding, New York City; W. K. Lente, at Seville, Volusia County, is president; R. P. Paulding is secretary, and T. W. Wilson is the treasurer.

Orange Belt; through the counties of Orange and Brevard; capital, $1,300,000; directors, M. R. Gruelle and W. C. Miller, Gainesville; J. H. Woodsum, Sylvan Lake; J. H. Macdonald, Lake Eustis; T. E. Wilson, Sandford.

St. John's Terminal; from a point within three miles of Jacksonville to the Central & Western R., Duval County; capital stock, $100,000; directors, C. D. Willard, Washington City, D. C.; J. M. Shumaker, Jacksonville; A. D. Bosnell, Jacksonville; Leonidas M. Lawson, New York.

St. Andrews & Choctowatchee; through Washington County; capital, $150,000; directors, F. Budler, Chicago; W. Miller, Point Washington; P. Knowles, Pensacola; C. C. Yonge, Pensacola; T. Hannah, Point Washington.

Georgia & Florida Midland; from the Georgia line in Gadsden County to a point on the St. John's River, in Duval County; through the counties of Gadsden, Leon, Jefferson, Madison, Taylor, Lafayette, Alachua, Bradford, Clay and Duval; capital, $2,000,000; directors, H. Disston, Philadelphia; A. P. K. Safford, New York; J. J. Dunne, Philadelphia; W. T. Forbes, Jacksonville; T. W. Palmer, Jacksonville.

St. Louis, Montgomery & Florida R. & Immigration Co., from Florence, Ala., to Chattahoochee, Fla.; capital, $1,000,000; directors, A. B. Tavel, Nashville, Tenn.; H. C. Armstrong, Notasulga, Ala.; H. G. McCall, Montgomery, Ala.; J. S. Jamison, Montgomery, Ala.; W. S. Ford, Notasulga, Ala.

Chattahoochee & St. Joseph; from a point in Jackson County, near Chattahoochee, on the Pensacola & Atlantic R.; through the counties of Jackson and Calhoun to some point on St. Joseph's Bay, with branches; capital, $500,000; directors, G. Lewis, J. A. Henderson, A. B. Hawkins, E. Lewis, W. O. Lewis, Tallahassee.

Arlington & Atlantic; from a point on St. John's River to a point on the Atlantic; capital, $100,000; directors, J. J. Daniel, J. Q Burbridge, G. B. Griffin, J. M. Schumaker, J. C. Greeley, J. E. T. Bowden, M. McDuff, H. Clark, R. P. Daniel, F. F. L'Engle, H. A. L'Engle, Jacksonville.

Thomasville, Tallahassee & Gulf; from a point on the Georgia line between Thomasville, Georgia, and Tallahassee, Fla., through the counties of Leon, Wakulla, and Franklin, to the Gulf of Mexico; capital, $1,000,000; office, Tallahassee; directors, C. H. Adams, New York; J. E. Page, Albany, N. Y.; E. Danforth, Elmira, N.Y.; W. V. Page, Albany, N. Y.; E. Lewis, Tallahassee.

Kissinnine & Ft. Meade; from a point on Walk-in-the-Water Lake to a point on Peace Creek, in Polk County; capital, $200,000; directors, W. T. Forbes, Jacksonville; C. L. Mitchell, Fort Meade; J. J. Dunne, Jacksonville; J. E. Robeson, Fort Meade; S. I. Wailes, Washington City, D. C.

Gainesville & Gulf; from Gainesville through the counties of Alachua, Lafayette and Taylor, to a point on the Gulf of Mexico at or near Deadman's Bay; capital, $1,000,000; directors, E. S. Carren, Arrsdenda; W. F. Rice, Arrsdenda; J. B. Dill, Gainesville; L. A. Barnes, Gainesville; N. R. Gruelle, Gainesville.

"THE WEIGHTS OF FRAMED GIRDERS AND ROOFS."*

BY JOSEPH HAYWOOD WATSON BUCK, M. INST. C. E.

WHEN THERE IS NO MOVING LOAD.

(1). Find the dimensions of each part of a girder of the strength required to carry the fixed load W, but not its own weight in addition, and note the sectional area of each member. Let the weight of this girder $= a$.

(2). Multiply the sectional area of each member by $\frac{W}{W-a}$.

WHEN THERE IS A MOVING LOAD OR WIND PRESSURE ACTING LONGITUDINALLY, AS IN THE CASE OF A ROOF PRINCIPAL.

For Large Structures.

(1). Find the dimensions of each part of a girder of the strength required to carry the fixed load W (including, in a bridge, its proportion of the floor, lateral bracing, rails, etc.), but not its own weight in addition, and note the sectional area of each member. Let the weight of this girder $= a$.

(2). Multiply the sectional area of each member by $\frac{W}{W-a}$ (this step being taken at once, in some cases reduces the additional material for stiffening the struts accruing from the next steps).

(3). Find the additional material required in each member to enable the girder to carry the moving load (in a roof to resist the action of the wind), and also in any new members which may be required for the same purpose, and note the sectional area of each member. Let the total weight of this additional material $= b$ (not to be added).

(4). Multiply the sectional area of every member, except the new ones, by $\frac{W+b}{W}$.

(5). Add the additional material found in (3), assigning to each member the increment of sectional area due to it, and inserting the new members, if any.

For Small Structures.

(1). Find the dimensions of each part of a girder of the strength required to carry the moving load, but not its own weight in addition, and note the sectional area of each member. Let the weight of this girder $= b$ (merely note this).

(2). Find the dimensions of each part of a girder of the strength required to carry $W + b$, but not its own weight in addition. Let the weight of this girder $= c$.

(3). Multiply the sectional area of each member as found in (2) by $\frac{W+b}{(W+b)-c}$.

(4). Add the material found in (1) allotting to each member the increment of sectional area due to it. If (1) has more members than (2), insert the additional members.

* From "Selected Papers" of the Institution of Civil Engineers

THE CIVIL ENGINEER.

The word *engineer* is supposed to have been adapted from the Italian *ingegnere*, a term originally applied to military artificers or superintendents of engines of war, catapults, ballistas, battering rams, etc., used in seige operations; the term thus included artillerymen as well as military engineers in the restricted sense now used. The construction of roads and moats, as well as of fortresses, at such an early epoch, fell partly into the hands of such men, who divided with the architect the work of building bridges, fortresses, buildings and structures of various kinds. When the principle of further division of labor, following on extension of amount, asserted itself more fully, the architect's sphere narrowed itself to urban and domestic building, that of the military engineer to seige works and constructions connected with actual warfare, while the whole range of work falling in neither of these classes became the domain of civil engineers. The term was certainly unfortunate, because illogical and inaccurate in expression; the more exact term for persons employed in making *structures*, distinct from engines of war on the one side and domestic buildings on the other, would obviously have been *constructors*.

Defective, however, as the term civil engineer may be, it is perhaps all that the English have borrowed from the Italian in this branch. It has been imagined by some that English civil engineering was by origin Italian; the adaptation of the word engineer from *ingegnere* probably forms nearly the only basis for this assumption. Nothing is less Italian in method, principle and feeling than English civil engineering.

If we look back to earlier history, we find that the earliest English engineering works, such as the drainage at Windsor, at St. James's Park and Westminster, the original water-works at London Bridge, in fact, nearly everything was done by Dutchmen, or, as they were then and should now be more correctly called, Hollanders. These really important men were the founders of civil engineering in England. The method of the Dutchman was perfectly distinct from that of the Frenchman, Italian, or of any one of semi-Latin-derived race. His designs were practical, careful and direct; his calculations and theories few and sound, his results well achieved and economic, devoid of pretensions and bombast; he obtained concessions on a sound basis and devoted himself to carrying out his designs personally, sometimes transmitting the continuance of his work to his sons and relations—in one case, that of London Bridge water-works, to surviving female relatives.

The Dutchman's knowledge was comparatively large, for it was equal to all the possible requirements of his work, and he was laborious to a high degree, spending his lifetime on his works. The earlier English civil engineers followed in the wake of the Dutchman and adopted his methods and his principles, his soundness, sense and practical management. Since that time English civil engineering has developed itself in accordance with local wants and peculiarities. Among the most marked of these were the working of coal and of iron on a large scale, the use of steam machinery and its application to almost every conceivable purpose, the need of water transport at a low cost and the development of a system of navigable canals, the necessity for more rapid communication, inducing the construction of a network of railways and so forth, to the present time.

The basis of it all was, however, undeniably Dutch, or Hollandish, in the same way as the Anglian, Frisian and Jutian, as well as the Anglo-Saxon and Danish origins of the English race remained the prevailing racial distinction. On the other hand, what is there in English civil engineering that is due to French or Italian sources? Remarkably little. Some old hydraulic experiments and some very incorrect formulæ for flow of water. Even in the electricity of early times, the Hollander was quite as advanced as the Italian, however much the Italian may claim to origination in certain special electrical matters. When Czar Peter wanted to practice and learn shipbuilding he did not go among the naturally favored and maritime Italians, but went to Holland and to England. The French, when wishing to supply Paris with water, sent commissioners to London to study the methods there adopted, and to secure some one capable of executing the necessary works. In more modern times, the light and knowledge thrown on the calculations of strength and stability of structures may certainly be said to be French, being nominally due to Lagrange, Lacroix, and others, but after all it was actually due to Newton, his methods and his fluxions, in a more developed application. Nothing can be less correct than to assign to English civil engineering an Italian or a French origin; the converse, however, is certainly true engineering.

CURRENT METER OBSERVATIONS IN THE TIDAL COMPARTMENT OF THE THAMES.

BY PROFESSOR W. C. UNWIN, M. I. C. E.*

These observations were made at Putney and at Westminister with two objects. One was to test a new form of current meter made by Messrs. Amsler Laffon, of Schaffhausen; the other was to try how far useful velocity observations could be carried out in a tidal stream.

The meter differs from ordinary meters in its mode of support, and in having an electrical signal. It is a screw meter fixed in gimbals allowing free motion in all directions. The axis of the screw is kept in the direction of the current by a conical rudder, which appeared to have quite adequate directing power. The meter is suspended by a steel wire with a weight of 40 kilogrammes below it. It is raised or lowered in the water by a small crab with an index, which shows the exact depth of the meter from the water surface. At depths at which it could be observed, the meter held its position in the water with very great steadiness, and alterations of position were made with great facility. The meter was used in depths of water varying from 2.2 to 7.3 meters.

At every 100 rotations of the screw an electric circuit is completed, and a bell above water is rung. The speed of the screw is therefore obtained by noting, with a chronograph watch, the time of 100, 200 or 500 rotations. The velocity of of the water is obtained from the speed of the screw by a suitable formula with constants determined by the previous experiments. This arrangement works very satisfactorily. The time was noted to fifths of seconds.

In velocity observation in ordinary rivers the chief difficulty arises from the unsteadiness of the water's motion and the eddies superposed on the general forward movement. In a tidal river there is the additional difficulty that the velocity at each point is continuously varying with the change of depth and surface slope. To obtain observations in a tidal river frequent enough to be useful, the observations must be made with considerable rapidity. In these experiments the author took entire charge of the meter, altering its position, noting the time and recording the results himself. Nevertheless, averaging six days' observations, one velocity was obtained for each three minutes, which was a very satisfactory rapidity.

Sometimes the velocities were observed at each meter of depth. More commonly velocities were taken at 0.5 meter below the surface, at middle depth, and at 0.2 meter above the bottom. Curves were exhibited giving the velocities at top, bottom and mid depth, during two ebb tides and during the period from the end of one ebb through the period of flow and into the next ebb. The fluctuations of these curves are not greater than is usual in velocity observations in rivers.

Calculations of the volume of flow at different periods of the tide could not be given without tables, but the following general results are interesting:

1. The change of the river depth begins markedly earlier than the change of direction of motion at the turn of the tide.

2. The relation of the surface and sub-surface velocities is similar to that in an ordinary river at all parts of the tide.

3. The velocities could not be observed exactly at the turn of the tide, but in a very short period after the direction of motion had changed the bottom water was in motion, with a velocity bearing about the same ratio to the surface velocity as at other periods of the tide.

4. The change of velocity for half an hour before and half an hour after the turn of the tide is very rapid.

5. The greatest velocity observed was a little less than one meter per second.

* Paper read before Section G of the British Association at Southampton.

THE TELERADIOPHONE.

M. Mercadier's researches in radiophony are well known, and one practical result from them is the multiple telegraph, which he has brought out under the name of the teleradiophone. This is an application of Professor Bell's selenium photophone, which was probably foreseen by Professor Bell himself. It is known that if an intermittent ray of light falls on a selenium cell in circuit with a battery and telephone a musical note will be heard in the telephone of a pitch dependent on the number of interruptions in the ray per second. On breaking up this musical tone by the interposition of a screen in the path of the ray, a telegraphic message can be sent after the Morse code. M. Mercadier employs the rays from a gas jet reflected by a mirror and focussed on a revolving wheel with holes driven through it round the edge. Behind this wheel is a selenium cell in circuit with a battery and telephone. Before the wheel is a small screen or disc connected with a lever or signaling key, which the operator can insert or withdraw from the track of the light, thereby cutting it off altogether at will. On manipulating this key, according to the Morse code, the words of a message can be sent in a manner similar to the harmonic telegraph of Mr. Elisha Gray. Two or more selenium cells and telephones can be connected in the same line circuit, and thus several messages be passed simultaneously over the same wire, provided the transmitting wheels have different numbers of holes and interrupt the ray unequally. The notes due to these different transmitters will have different pitches, but by means of suitable resonators attached to the telephones the particular note desired may be strengthened so that the clerk listening at that telephone will easily hear that note distinctly, and no other. With ten sets of apparatus, each giving twenty dispatches of thirty words each per hour, the total transmission would be 6,000 words per hour.

BLOWING UP ICE IN THE ELBE.

There lie in the River Elbe, north of Mlikojed, two sand banks connected by a stone dam, which divide the river for over half a mile into two branches. That which lies along the left bank is the largest, and is the navigable channel. In February, 1881, this channel was so far blocked up with ice that only about 35 ft. in the middle remained free for the passage of ships. The ice—which was about 10 in. thick—was heaped up, one sheet over the other, and formed a dangerous overhanging barrier, which forced the water into the right-hand channel. The buildings on the shore were thus threatened with flooding, and the proper passage was in danger of being blocked. Under these circumstances it was decided to restore the normal order of things by blowing up the ice with gunpowder, which explosive was chosen for reasons of economy. Single charges were used where the

ice floated, and was only one layer thick; but 11-lb. charges were employed where it was two layers thick, and 13¾-lb. where it considerably exceeded this. They were inclosed in very strongly made tin boxes. These were closed with a cork stopper, plastered over with a mixture of pitch, tallow and linseed oil. Altogether 1,232 pounds of powder was disposed in eleven series of from six to sixteen mines each, placed at about 40 ft. apart, inserted through holes made in the ice, and driven down to its under surface. Each series was discharged simultaneously by electricity, and there were no miss-fires. The lower part of the icefield was first attacked, and then some of the mines in the upper part were discharged. The effect of these was to loosen a quantity of ice, which by its mere weight carried away a great mass 150 ft. long lying below it before the mines for breaking up this latter could be fired. The total result was most satisfactory. With five days' labor about 536,000 square feet of ice were cleared away, and a free channel opened of 3,000 ft. long, and from 130 ft. to 140 ft. in width.

NEWS OF THE WEEK.

CROWN WATER METERS.—The increasing popularity of the above meter is very amply testified to by the letters from well-known water companies published in our advertising columns this week.

WATER-WORKS FOR WINDSOR, N. S.—Active operations in laying the water mains and distributing pipes for the new water-works will commence as soon as the season opens. The dam and gate-house are now completed. The total estimated cost is $50,000. The works are being built according to plans of E. H. Keating, C. E., and under his personal supervision.

WILMINGTON (DEL.) SEWERAGE.—The Committee of the Common Council of Wilmington appointed to report on the advisability of building the system of sewerage proposed by R. Hering, Sanitary Engineer (referred to in ENGINEERING NEWS, page 95 *ante*), have reported in most favorable terms. The text of the Report of Committee is published in full in the Wilmington *Morning News* of the 1st inst. The last clause is as follows: "In conclusion, your committee believe that in the execution of this project not only would local interests and labor be benefited, but also that the advantages to our citizens in the future by the establishment of the fact abroad that we have a city second to none in its system of underground drainage, and which must result in a diminished death rate and an improvement in the general health, cannot be estimated."

The *Morning News* says editorially: "The report gives all the details, and this is the conclusion. We are spending all the money needed now. It is not a question of additional expense; it is merely a question as to whether or not we wish to get the safest, the most useful and the most profitable thing for our money."

WATER-WORKS, TOMBSTONE, ARIZONA. — The Tombstone (Arizona Ter.) *Republican* describes, in a recent number, the new water-works for supplying that city and the surrounding mines. The supply is from springs in the Huachuca mountains, 25 miles from the city. The main line, of that length, is of 7-inch lapwelded, rolled wrought-iron pipe, in lengths of from 14 to 20 feet, and laid about two feet below the surface. So perfect is said to be the work that in the whole line "not one defective joint was found, nor one collar broken." The pipe was made and the work executed under the direction of the Pennsylvania Tube Company of Pittsburgh.

STREET RAILROAD.—An ordinance has been introduced in the City Council of Indianapolis, Ind., "authorizing the construction, extension and operation of the Metropolitan Railway line in and upon the streets of Indianapolis."

RAILROAD SCHEME IN FLORIDA.—A plan is being considered for building a new railroad from Montgomery, Ala., to Chattahoochie, connecting the Louisville & Nashville system with the Florida Central and Western and Transit roads.

SPRINGFIELD & SOUTHERN RAILROAD.—The survey will soon be completed.

TELEPHONE IN ST. LOUIS.—There are 975 miles of wire operated. The stations on Dec. 31 numbered 1,015. The business is being extended to the towns in the vicinity.

WATER-WORKS, MILWAUKEE, WIS.— On account of the inlet of the water-works being clogged with ice, the supply in the reservoir has become low. Pumping is of no use. A bill is now before the Legislature authorizing the city to issue $400,000 of additional water bonds.

SCHOOL BUILDING.—The Lynchburg, Va., council has voted $17,000 for a colored school building.

SABINE PASS & TEXAS NORTHERN RAILROAD.—Work has been stopped on the grading and will not be resumed until it is seen what the State Legislature will do.

GAS-WORKS BURNED.—The works of the Lake Gas Company, Chicago, have been destroyed by fire. Loss about $30,000.

JACKSONVILLE, ST. AUGUSTINE & HALIFAX RAILROAD, FLA.—The grading is all done and 12 miles of iron laid. Enough stock on hand to lay 13 miles more. The road will soon be completed.

IMPROVEMENTS AT THE HIGHLANDS.—An estimate of the cost of improvements commenced and projected on the Atlantic Highlands for the present year gives a total of $500,000. A railroad is to be built from the camp-meeting grounds to Keyport, where connection will be made with the New York & Long Branch Railroad, while another spur will run to Middletown.

CLEARFIELD & JEFFERSON R. R.—Application has been made to the Pennsylvania State Department for a charter for this road. The line will run from a point in Clearfield County, on the western side of Clearfield Creek, near Witmer Run, at the terminus of the Bells Gap Railroad Company when completed; northwestward through Clearfield and Indiana Counties to Punxsutawney, Jefferson County, a distance of 32 miles. The capital stock is $1,000,000, and the directors are Charles Berwind, Aaron Fries, John Reilly, J. N. Dubarry, F. S. Lewis, J. H. Converse, Allison White.

FLOOD LOSSES.—A detailed estimate places the flood loss in Indiana at $4,448,000.

CINCINNATI & BALTIMORE R. R.—The directors have called a meeting of the stockholders for March 26, to vote on the contract for the sale of the road to the Cincinnati, Washington & Baltimore Railroad Co. according to the terms of agreement for reorganizing the Marietta & Cincinnati Railroad Company.

CALIFORNIA R. R. PROJECTS.—Newspapers in the mountains are still talking about the project of a railroad from Marysville to Challenge Mills and beyond, although the project has received little attention here. The North San Juan *Times* says: "Parties are engaged in getting up a company to construct a wide-gauge railroad from Marysville, or a point near that place, via Brown's Valley and Challenge Mills, to some point above, where it will command the trade of Sierra and Plumas Counties and the upper part of Yuba County. The distance from Challenge Mills to Camptonville, via Bullard's Bar, is eighteen miles, with a good graded road between the two places. From Nevada City to Camptonville is twenty-three miles. The construction of such a road will necessitate the construction of a railroad from Grass Valley to this place, and thus bring the Camptonville people within ten miles of the terminus. It is necessary for the narrow-gauge company to retain the Sierra County freighting to make their road profitable.—*Marysville Appeal.*

TEXAS & PACIFIC R. R.—This road now has six bridge, pile-driving and construction trains at work, each having a large force of men, especially skilled in that kind of work, rebuilding and strengthening the bridges on the New Orleans Division.

KENTUCKY CENTRAL R. R.—CINCINNATI, O., Feb. 23.—The managers have negotiated $1,000,000 bonds, realizing enough to pay the bonded indebtedness and leaving a balance sufficient to complete the road to connect with the Knoxville Extension of the East Tennessee, Virginia & Georgia system.

SCHOOLHOUSE CONTRACTS AWARDED. — The Philadelphia Board of Education has awarded two contracts for school buildings; one to P. H. Somerset, for $31,449, and the other for alterations and additions to E. Wright, for $4,970.

TOLEDO & MICHIGAN R. R.—Work on this road in the vicinity of Battle Creek is being vigorously pushed forward.

WATER-WORKS, SAN FRANCISCO, CAL.—The Board of Supervisors having reduced the water rates, the Spring Valley Water Company has stopped pumping and will only distribute water received by gravity. The rates were reduced 37½ per cent.

BIDS FOR IRON WORK.—On Thursday last bids were opened in the Treasury Department for the iron work of the post-office and sub-treasury at Boston: Bartlett & Hayward, Baltimore, $23,250; Chelmsford Company, Boston, $23,254; Phœnix Iron Company, Trenton, N. J., $20,600; Hough & Ketchum, Indianapolis, $25,674; G. W. & F. Smith, Boston, $17,000. The contract will be awarded to the latter firm.

AMERICAN STEAM-HEATING COMPANY.—The Grand Jury has made a presentment declaring that the engineering and mechanical work of the American Steam-Heating Company, this city, are alike bad, and that the Grand Jury would have indicted the company's works and plant as the nuisance which they undoubtedly were if the company had not acknowledged the defects and shut off steam pending a change of the system. The Grand Jury advise the Commissioner of Public Works to see that hereafter this company shall lay its steam pipes as far as possible from the gas pipes. They find that the streets are so full of pipes already that no further franchise to use them should be granted unless the necessity is proven, full compensation is paid and the city's consent is obtained. They deplore the legislative interference that gave to the steam-heating company a franchise refused by the city, and so enlarged it as to leave the streets and even the city's sewer and water pipes at the mercy of the company. They find nothing to censure in the operations of the New York Steam Company.

LABORERS' WAGES IN DELAWARE.—The Georgetown and Ellendale gangs of section hands on the Junction and Breakwater Railroad struck for an increase of twenty-five cents a day in their wages. They have been receiving one dollar.

LONG ISLAND ROAD SCHEMES.—Specifications were filed in Albany for a mile and a quarter of road, extending from Fresh Pond, on the Long Island Railroad, to a connection with the Manhattan Beach Railroad at East New York. Mr. Austin Corbin, the President of the Long Island Railroad, has sailed in the Servia for Europe. Mr. J. R. Maxwell, the Vice-President, said to a reporter that the cost of right of way and the construction was estimated at $50,000. The piece of road, he added, could be built in 30 days, and work could be begun at once. The plan was to run trains to Manhattan Beach from Hunter's Point instead of Greenpoint, although local trains would continue to and from the latter place. The lines to Manhattan Beach were to be converted from narrow into standard gauge roads, and would conform to the gauge of the entire Long Island system. The narrow-gauge locomotives in the Bay Ridge fire were being repaired and would be sold, with the remainder of the rolling stock belonging with them. Fifty new cars had been ordered for the Manhattan Beach road, and 25 for the Long Island road. Twenty locomotives had also been ordered, 10 for each road. Mr. Maxwell said all but 70 miles of the Long Island road was laid with steel. Six thousand tons of steel rails had been ordered to replace the iron, and the work would be completed by July 1. Mr. Corbin, while in Europe, will look after the interests of his ocean steamship scheme from Montauk Point to Milford Haven. The Long Island road will not be extended to Montauk Point until the steamship project is developed.

WATER-WORKS NEEDED.—Quincy, Mass., wants a water supply, and to accomplish this the Quincy Water Company has been formed.

WATER-WORKS, WICHITA, KAN.—The contractors have gone to work and, with favorable weather, will complete the work early this summer.

WATER-WORKS, FARIBAULT, MINN.—George M. Andrews, county surveyor, has been authorized by the council and is making a survey to ascertain elevations, etc., preparatory to building the water-works. This matter will be brought up at the next meeting of the common council and will be fully discussed.

LIBRARY FOR PITTSBURGH, PA.—The city has accepted the offer of Mr. Andrew Carnegie of $250,000 for a public library, but in order to secure it will have to raise a like amount.

INTERNATIONAL R. R. & STEAMSHIP CO.—This company has been incorporated by the Florida Legislature. The object is to build a railroad down the backbone of the peninsula to Key West.

SUSQUEHANNA & ALLEGHENY R. R.—This company has been chartered in Pennsylvania. Capital $1,500,000. It will build 150 miles of road from Punxsatawney, Jefferson County, through Indiana, Clearfield, Clinton, Lycoming and Union counties. W. H. Brown is the President.

HENNEPIN CANAL.—The Secretary of War has received the preliminary report of the survey of the Hennepin Canal. The Morois Dosier route has the preference in the estimates. Its length is given as 65 miles, with 31 locks. The estimated cost of construction of the canal by this route, with the feeder, is put at $6,811,367.50. This includes the right of way. The cost of maintenance and ordinary repairs annually is put at $88,600. The required dredges will cost $36,000. The second route proposed is that known as the Watertown route, with a length of 65 miles and 32 locks. The estimated cost of construction of the canal and feeder, including the right of way, is $7,207,646.88. The estimated annual cost of maintenance and ordinary repairs is put at $91,345. The dredges are estimated at the same amount as in the other case. The Rock Island route is put down as necessitating a canal 75 miles in length with 35 locks. The estimated cost of the construction of the canal by this route, including the feeder and right of way, is

placed at $6,672,890.67. The estimated cost of maintenance annually, with ordinary repairs, is put at $94,820. There is $36,000 allowed for dredges. The length of the feeder from Rock River at Dixon, is 27 miles, and its estimated cost (included in the above) is $1,664,117.52. For the enlargement of the Illinois and Michigan Canal $2,298,919 is estimated. The length is 96 miles, with 16 locks. The estimated cost of maintenance is put at $50,000.

NARROW-GAUGE ENTERPRISES IN THE MINING COUNTRY.—J. P. Whitney, of Boston, is en route to Grant County, New Mexico. Mr. Whitney is President of a company of Boston moneyed men who are engaged in building several narrow-gauge railroads in Western New Mexico. The company has just finished the grading of the Silver City, Deming & Pacific road, which runs through the center of Grant County from Deming to Silver City, a distance of 46 miles. Deming is the junction of the Atchison, Topeka & Santa Fe and the Southern Pacific and the Texas & Pacific roads, which gives the new road an excellent outlet. Mr. Whitney has made the arrangement for track-laying, which is to commence next week. The road will be continued to a point on the Atlantic & Pacific, thus connecting the railroad system of New Mexico. The company will build another road from Clifton, Arizona, 100 miles westward, which will run through the richest mining country in Arizona. A survey of a road from Silver City to Magollon is now being made. This line will run through a district rich in mineral and timber wealth. Along the route are 3,000,000 acres of fine timber. A road to be a continuation of the Southern Pacific will also be constructed from Lordsburg, Arizona, to Clifton, a distance of 80 miles.

WATER-WORKS FOR ROCK ISLAND, ILL.—Work on the protecting pier at these works is well along toward completion.

NEW DEPOT.—The West Shore road will build a $250,000 depot at Buffalo.

TELEGRAPH POLES.—The work of setting the telegraph poles for the West Shore Road will be begun at once. The company has closed a contract for 12,000 poles.

HOUSTON, EAST & WEST TEXAS R. R.—Chief Engineer Cross, of this road, will at once push forward construction from its present terminus to Nacogdochee. The road will be completed within three months.

NEW STEEL CO.—The Hartmann Steel Company, of Pittsburgh, Pa., has filed articles of incorporation. Capital, $300,000.

WATER SUPPLY OF SAN FRANCISCO.—J. G. Divoll and William D. Long have filed with the Board of Supervisors a petition for a franchise to lay water mains in the streets and alleys of San Francisco, to bring water from the Tuolumne River. The petitioners represent that they are the owners of 25,000 sq. in. of water in a continuous stream in the Tuolumne River, and they intend to use this water for irrigation, manufacturing and domestic purposes in several counties of the State, including San Francisco. The elevation of this water supply, as applied to this city, it is claimed, is such as will enable the Fire Department, by use of hydrants, to throw streams over the housetops of buildings on the highest situations. In consideration of the franchise, Messrs. Divoll and Long propose to furnish free of cost all the water that the city may require for fires, flushing sewers, park irrigation, etc. They express themselves as willing to bind themselves to begin laying the water mains in this city within three years and to have the system completed inside of five years.

PANAMA CANAL.—M. Charles de Lesseps has left France for the isthmus with a number of scientific men and engineers. Many laborers continue to arrive, and although higher than the estimated wages will have to be paid them, the work is not likely to be stopped on that account.

THE CAPITOL BUILDING FOR COLORADO.—Commissioners appointed to build the new Colorado capitol ask for more money before the plans are touched. The Legislature appropriated $1,000,000 and provided that to start with a wing should be put up for $200,000, and the commissioners say the sum is too small for that portion of the building.

ATCHISON, TOPEKA & SANTA FE R. R.—Within the next 60 days this road will commence building the road from Guaymas on the Gulf of California to El Paso.

MEXICAN CENTRAL.—It is expected that the track will reach the city of Aguas Callientes in April. The road is already more than 50 miles north of Lagos.

FLORIDA SHIP CANAL.—A Tallahassee, Fla., dispatch says that the charter for this company has passed the assembly.

SUIT INVOLVING A LARGE SUM.—The Hon. Joseph E. McDonald, representing Joseph Forsythe, of Chicago, yesterday filed suit in the Federal Court for the foreclosure of a mortgage involving a vast amount of wealth. The suit is against William N. Green, Charles B. Alexander and the East Chicago Improvement Company, and is for the foreclosure of a mortgage upon 8,000 acres of land lying at the mouth of Wolf River, which was purchased in November, 1881, with a view to constructing a belt railroad upon it and a grand harbor. The scheme was an ambitious one, and became generally known as the "East Chicago enterprise." The land cost $1,000,000, and one-third of the purchase money was paid, but the $20,000, interest on the residue of $666,666.66 became due on Jan. 1, 1883, and hence the suit for forclosure. The scheme has been abandoned, it is said, as impracticable.—*Indianapolis Journal, Feb.* 22.

SANITARY MEASURES IN CINCINNATI.—On the 26th ult. a large meeting of citizens was held in the Chamber of Commerce to discuss a bill proposing to create a street and sanitary commision for two years, and to place $1,000,000 at its disposal. Messrs. H. C. Urner, M. E. Ingalls, E. F. Noyes, J. D. Cox, and J. L. Keck spoke in its favor, and Messrs. A. Hickenlaper and J. D. Caldwell against it. The vote was practically unanimous in favor of the measure.

SAN JOAQUIN & SIERRA NEVADA R. R.—Work has ceased and the surveying party discharged. The road is constructed as far as Wallace, Cal., and located for 15 miles further. Lack of funds is the reason.

SPUYTEN DUYVIL ACCIDENT DAMAGES.—The New York Central Railroad Company has compromised at $29,000 the $100,000 claim of Mary Daniels, who was hurt in the Spuyten Duyvil disaster last year. The company has paid A. B. Valentine, whose son and the latter's bride were burned to death in the same disaster, $10,000, $5,000 for each life.

WATER-WORKS WANTED AT RED BANK, N. J.—The persistent refusal of the Town Commissioners to make a contract for water is bringing about a result long predicted. On the 23d ult. the agents of the Star and Westchester Fire Insurance companies of New York were in town cancelling policies held by their companies, and other companies are expected to act in a similar manner.

GEORGIA PACIFIC R. R.—Work on this road is progressing rapidly. The distance from Atlanta, Ga., to Anniston is 103 miles, and of this 101 miles have been laid, leaving a gap of 2 miles, the grading of which is done and the steel rails sent forward. The road is being operated from Atlanta to a point near Edwardsville, 70 miles, and it is expected that trains will run through to Anniston in a very short time. From Anniston to the Coosa River is twenty-three miles, of which twenty miles are graded and the balance will soon be done. The steel rails for this twenty-three miles have been bought for March delivery. Progress is being made on the masonry of the Coosa River bridge. This bridge will be built of iron, and the contract has been let. From Coosa River to Birmingham is forty-one miles, of which eleven miles have been graded and upon the balance of which large forces of laborers are engaged. It is expected trains will run through from Atlanta to Birmingham by Nov. 1. From Birmingham to Columbus is 125 miles. No work has yet been entered upon from Birmingham west. From Columbus east, forty-eight miles have been laid, and quite an amount is under contract to be completed in April, on which the grading is well advanced, large forces of laborers being engaged. Steel rails for this have been bought, and have gone forward in part. That portion of the road in operation, between Atlanta and Anniston, is provided with a sufficient equipment for present business, and the full equipment of $2,000 per mile for those 103 miles has been bought and gone forward. The contract has been closed for fourteen new Rogers locomotives, which will be built and delivered during the coming summer. Rails have been purchased and are now en route for the track between Anniston and the Coosa River.

CANAL CONNECTING THE ODER AND VISTULA.—The construction of a canal between the Oder and the Vistula has been undertaken by a private company, and the preliminaries are already in progress. The canal will connect the coal and iron districts of Upper Silesia, the rock-salt and limestone districts of Posen, and the agricultural districts of East and West Prussia.

RIGHTS OF A RESERVOIR COMPANY.—FALL RIVER, Feb. 23.—An important hearing was begun before the Legislative Health Committee this afternoon in a contest which involves the right of the Watuppa Reservoir Company to flow certain marsh lands on the borders of Watuppa Lake and the right of the local Board of Health to compel filling in such portions of the lowlands as are deemed sources of danger to the public health. The greater portion of the city is directly interested in the result of the hearing, and as the water company claims $12.50 for every rod filled in, and the land thus filled is several miles in area, the damages would be very heavy. The company is vested by Legislative act with the privilege of flowing, and eminent legal authorities say the Board of Health, by specifying the means, "filling in," instead of ordinary abatement of the nuisance, exceeded its powers.

PENNSYLVANIA, VIRGINIA & OHIO R. R.—This company has been chartered by Pennsylvania. The road will run from Miller's Run, in Fayette County, through Washington County to the dividing line between Pennsylvania and West Virginia, a distance of 15 miles. The capital is $150,000. Albert N. Sutton, of Pittsburgh, is the President.

WATER-WORKS AND SEWERAGE WANTED.—White Plains, Westchester County, N. Y., is considering the matter of building water-works and introducing a general system of sewerage.

THE IRON AND METAL MARKET.

PHILADELPHIA.

STRUCTURAL IRON.—The mills are running very short of work and competition for new business is very close. Prices are about as last quoted, say 2.5c. for Angles, 3.3c. for Tees, 3.5c. for Beams and 3.7c. for Channels.

RAILWAY FASTENINGS.—Spikes are steady at 2.8c.; Fish Plates and Splice Bars, 2.3@2.4c.

PITTSBURGH.

WROUGHT-IRON PIPE.—There is no scarcity of orders, but prices are very unsatisfactory, and manufacturers generally are refusing to contract ahead at present rates. Discounts on Gas and Steam Pipe remain unchanged at 70@70 and 5 per cent.; on Boiler Tubes, 55 per cent. off; Oil-well Casing is quoted at 50@60c. per foot, net; do. Tubing, 15@17c., net.

RAILWAY TRACK SUPPLIES.—Railway Spikes have been reduced to 2¼c., 30 days. Splice Bars have declined to 2.20@2.25c.; Track Bolts, 3¼c. with Square and 3.60@3.65c. with Hexagon Nuts.

CHICAGO.

MANUFACTURED IRON.—Quotations remain unchanged, with a good, fair demand existing. We quote: Bar Iron, 2.30@2.40c. rates; Angle Iron, 3.10@3.30c. rates; T Iron, 4c. rates; Beams, 3.80c.; Channels, 3c.; Tank Iron, 3@3.20c. rates; Sheet Iron, 3.20@3.40c. rates; Norway Original Bars, 4¼c. rates; Norway Re-rolled Bars, 5¼c. rates; Ulster, 4¼c. rates; Low Moor Iron, 8c. rates; Nuts and Washers, 8c. off list; Wrought Boat Spikes, 3¼c. rates.

CINCINNATI.

PIG-IRON.—The late floods in the Ohio have so far subsided as to enable a general resumption of business in the foundries, machine shops and rolling mills during this week. Since the subsidence of the waters in this immediate vicinity, it is found that the absolute losses of property by the flood, although very great, have been largely overestimated. From a sanitary point of view it is thought the late flood will finally prove to be a benefit rather than an injury along the river and within the limits of Cincinnati, Newport and Covington, as all the cellars, back alleys, sewers, vaults, &c., are being thoroughly cleaned and ventilated, a treatment that many of them have not had in a quarter of a century. Many of the factories and storehouses that have lately been flooded are being overhauled. Defects in foundations and the woodwork, from age, are discovered only in time to save great damage to machinery and other property. During the past week there has been a fair trade in all kinds of iron, orders being confined to small lots for intermediate uses, quotations covering them as follows: No. 1 Hanging Rock Charcoal Foundry, $25@$26; No. 1 Hanging Rock Coke Foundry, $23; No. 1 Southern Coke Foundry, $21.50@$22; No. 2 of above, from 50c. to $1 less; Silver Gray Softeners, No. 1, $22; No. 2, $21; No. 3, $20; Silver Gray Softener and Fluxer, $22.50; Forge Irons, $19.50@$24, covering Stonecoal, Coke and Charcoal kinds; Car-Wheel Irons, Cold-blast Charcoal, $30@$31; Warm-blast, $26@$28; Blooms, Best Charcoal Hammered Flanging, $50; Pig and Common Scrap, $35@$40; Scrap Iron—Old Rails, T's and D. H., $25.